MECHANICAL ENGINEERING

· DECEMBER 1949 ·

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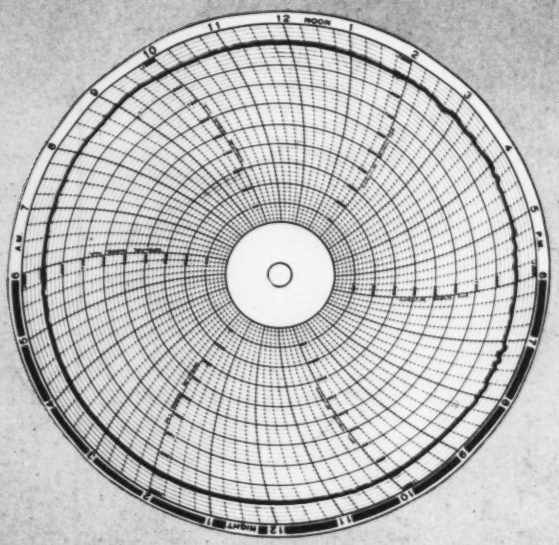
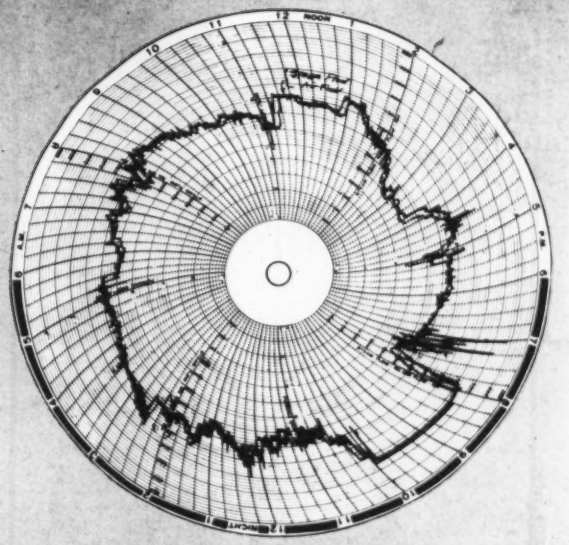
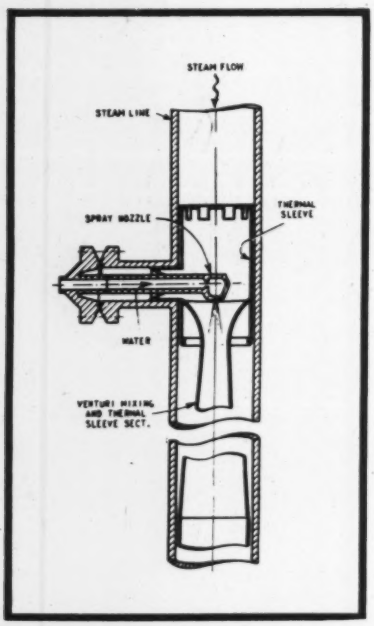


Typical steam-temperature chart from a large central station boiler equipped with B & W Spray Atemperators shows uniformity of final superheat temperature.



Steam-flow chart shows wide load variations on the same boiler throughout the corresponding period of operation.

Precision Control of Superheat



Special venturi-shaped liner mixes atomized spray with steam, away from direct contact with pressure piping surfaces.

For many high-temperature boiler installations, B&W Intermediate Spray Attemperation provides the most effective means of superheat control, and often at demonstrably lower cost than other types. Located between primary and secondary superheaters, Spray Attemperators offer the obvious economy of reduced alloy-tube requirements by maintaining uniform tube temperatures in the second stage, where temperatures are highest. Harmful impingement of spray water on pressure-piping surfaces is effectively prevented by a special venturi liner, which also assures rapid evaporation of the spray water and dry steam to the second stage superheater (see illustration, left).

These facts help explain why so many power companies prefer B&W Spray Attemperation. Have your B&W representative explain fully its advantages for safe, efficient high-temperature operation.

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 71 NUMBER 12

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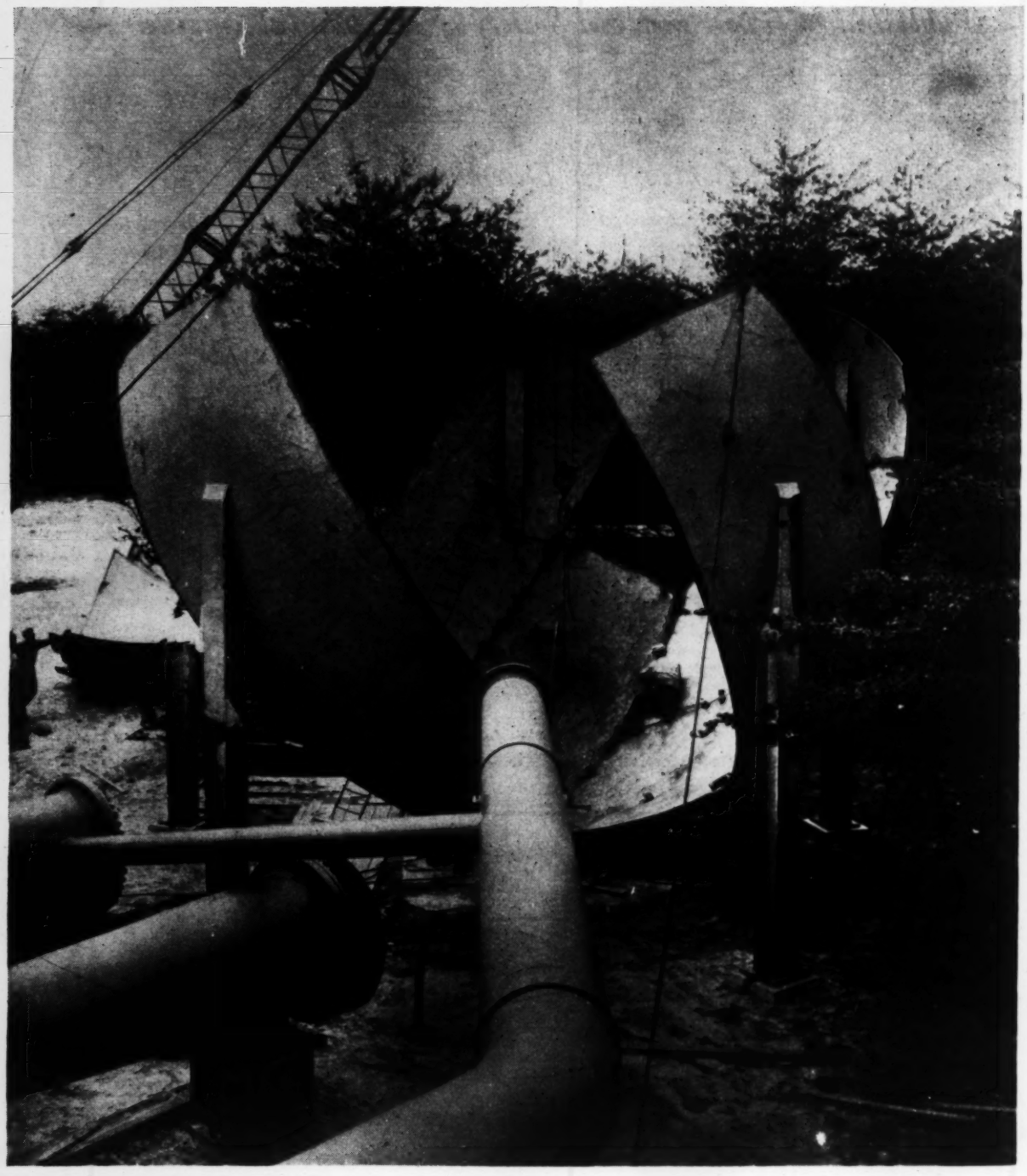

Icosasphere in Process of Erection

(This welded sperical tank, called an Icosasphere, is being built by Pittsburgh-Des Moines Steel Company, Pittsburgh, Pa., by a new method designed to reduce scrap loss and welding. Note rectangular shape of plates. For further details see pages 1036 and 1037.)

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MECHANICAL ENGINEERING

DECEMBER
1949

GEORGE A. STETSON, *Editor*

ECPD at Chicago

TO ONE who has attended every annual meeting of Engineers' Council for Professional Development, who has watched its growth and recorded its activities, the recent meeting at Chicago, reported elsewhere in this issue, was a gratifying experience. More than at any other time one recognized an adherence to objectives, a sense of direction of purpose, and a substantial record of achievement. As James W. Parker, who retired as chairman after three years of service, said at the dinner, ECPD may not have acquired great velocity, but it certainly possesses much momentum.

One wishes that Calvin W. Rice, whose years of service as Secretary of ASME were largely devoted to enhancement of the prestige of the engineer and to fostering the co-operation of engineering societies in programs relating to their mutual interests and the national welfare, could have been present to take satisfaction in this demonstration ECPD affords of the practicability of the principles he urged upon the profession.

One wishes that W. E. Wickenden, from whose studies of engineering education the concept of ECPD sprang, could have been present to listen to the words of high praise of his recently published "Professional Guide for Junior Engineers" and to realize that the seeds of professional service which he planted with his popular "Second Mile" have sprouted, flourished, and borne fruit in the organization to which he brought so much and which he served so faithfully.

One wishes that Conrad N. Lauer, under whose forward-looking leadership of the ASME Committee on the Economic Status of the Engineer a nucleus was provided around which the desire of engineers for greater unity in their profession crystallized in the formation of ECPD, could have been present to assess the extent to which this desire has been advanced.

One wishes that C. F. Hirshfeld, first chairman of ECPD, could have been present to see how the original plan of a program of activities that would embrace the life of an engineer from the time he first considers his choice of a career, through the undergraduate years at college and the postcollege years on the job, into the full maturity of his professional life when he is recognized by membership in an engineering society and by registration as a professional engineer, has come ever closer to fulfillment.

One wishes that Gen. Robert I. Rees, who made such a brilliant and fundamental start with a practical program of self-help and self-appraisal by engineering graduates caught in the stagnation of the "postcollege slump," could have listened to the plans outlined by Mr. Monteith that are to be put into effect at the community level.

One wishes that Prof. C. F. Scott, whose vision always outran the progress of new ideas, who preached ceaselessly the need for unity of the profession, could have been present to vote with the Council its approval of a report on uniform grades of membership.

One wishes that Dean R. L. Sackett could have been present to learn what progress has been made in guidance work with high-school-boys and about the plans of Mr. Deutsch's committee who will spread their work into ever-widening areas at the community level.

One wishes that these and a host of other worthies, now departed, could have taken comfort that their tasks have been assumed by other men and the enthusiasm and zeal for a great cause are burning more brilliantly than ever.

There was a time when these pages carried the warning that the success of ECPD would depend upon its ability to arouse the active interest and participation of an ever-increasing number of men in ever-expanding areas of the engineering profession. It was evident at Chicago that a drying up of the source of active men with new ideas and new enthusiasm has not occurred. Instead, the "new blood" has been found, the ideals and objectives have been maintained, and progress, if slower than some could wish, has been sure and soundly based.

There was a time when it seemed as though the only concrete accomplishment of ECPD would be the accreditation of curricula in the engineering schools and that even this achievement might become a useful mechanism rather than a living and expanding force for the greater benefit of the engineering profession. Yet recent years have seen the expansion of the accreditation program into the field of programs of the technical-institute type. And at Chicago a statement in respect to the "differentiating characteristics of an engineering curriculum" demonstrated that long association with the task of improvement of engineering education has brought keenness of insight to those who have labored at it and a penetrating sense of analysis to the perplexing question as to the manner in which the approach of the engineering school to the teaching of disciplines that are common to many other curricula is unique. Here indeed is evidence of the virility of the philosophy of those who direct this great work.

There was a time, too, when some persons feared that the spirit of ECPD, in spite of good intentions and wide publicity, might remain within an academic and professional hierarchy and never seep down into the grass

roots of the engineering profession where its benefits were intended to be effective. But even this fear was further dissipated at Chicago as, indeed, it had to be at Montreal and at Detroit. The holding of annual meetings of ECPD in different areas of engineering concentration has served to broaden the base of understanding and interest. The warm reception of Canadian engineers at Montreal, the attempt to interest industrialists and engineering-school deans at Detroit, and the emphasis on activities at the community level, evident at Chicago, have done their part in letting an ever-growing circle of engineers and educators witness ECPD at work.

James W. Parker has set a standard of leadership and wise counsel as chairman of ECPD that will be difficult to maintain. One who has witnessed his devotion to a task that requires time and intelligence, who has sensed the direction and depth of his planning, who has admired his meticulous pains to see that every point of view is permitted expression and every decision is taken with a full understanding of its significance, can find abundant reasons for the progress made during the three years of his administration. Now that the chairmanship has passed from the industrial to the academic area of the engineering profession, it is indeed fortunate that Mr. Parker's successor should be Harry S. Rogers, an administrator with a philosophical habit of mind and a reputation of being astutely practical. Under his wise leadership ECPD should continue its forward progress.

But ECPD is largely a counseling and co-ordinating agency which must make its work effective through the engineering societies, and the societies, in turn, can do little, except at the national and administrative level, without the personal services of their members working at the community level. The degree of success with which ECPD can stimulate action by individual engineers and local groups of engineers in attaining its objectives and in benefiting engineers of all ages and the nation which sorely needs their services, depends on how effectively and how generously these engineers and groups will respond to the stimulus and carry forward the programs that committees of ECPD are preparing for them. There is a vast amount of practical work to be done, and in the variety of that work lies opportunity for the exercise of the particular talents of every engineer.

Francis Hodgkinson

FRANCIS HODGKINSON, whose death occurred on Nov. 4, 1949, was a living link between engineering in Great Britain and the United States and between the era of the reciprocating steam engine and that of the steam turbine. He was typical of a remarkable, but frequently forgotten, group of Englishmen who acted as unofficial ambassadors of the industrial empire of Great Britain during the years that preceded the first world war. These men accompanied into alien lands the prime movers and ingenious machinery designed and built in the British Isles and spread them over the face of the earth to form the basis of a new industrial economy, to raise the standard of living, and to supplement the arts of agriculture and handicrafts that had been the basis of national wealth for many centuries. Working alone, with handicaps of language, unfamiliar customs, and inadequate tools, erection equipment, and skilled helpers, these men were thrown largely upon their resources of self-reliance and ingenuity to accomplish their missions, but they carried wherever they went concrete evidence of the industrial and engineering supremacy of their native land. It was through such men that the dreams of inventors materialized, for it was their duty to make machines work and to train others to operate them successfully.

It will be remembered that the imagination and inventive genius of George Westinghouse were captured in his youth by the prospect of substituting for the reciprocating engine one of a rotary type which would ideally be suited to the direct drive of many types of continuously revolving machines, of which the electric generator was to afford the most conspicuous example. It was natural, therefore, when Westinghouse learned of the success of the steam turbine in England, that he should instruct his vice-president, Emil E. Keller, in 1895, to procure from Sir Charles Parsons the license to manufacture the Parsons turbine in the United States. And it was natural that Keller, himself a mechanical genius, should insist that Parsons permit Francis Hodgkinson, who had been associated with the British inventor since 1885, to join the Westinghouse Machine Company to assist in the manufacture, installation, operation, and improvement of this new type of prime mover. As a result of the negotiations Hodgkinson came to the United States where he fully justified the confidence and farsightedness of Keller and distinguished himself in his adopted country by rising to the top of his profession. His name will be forever linked with the steam turbine in the United States.

Hodgkinson was born in London on June 16, 1867, and was educated at the Royal Naval School, New Cross, and by means of night courses undertaken at Durham University. He was apprenticed to Clayton and Shuttleworth, agricultural engineers, after which he went with the C. A. Parsons Company where he became superintendent of field work. There followed a tour of duty, 1890–1892, as an engineer in the Chilean Navy and in telephone and electric-light engineering in Peru. In 1894 he returned to Parsons, and in 1896 came to the United States, where he remained with the Westinghouse organization until his retirement in 1936.

During his long and useful life Mr. Hodgkinson had many distinctions. He was an Honorary Member of ASME and served it as vice-president and chairman of the Power Test Codes Committee. He was a member of the AIEE, the Engineers' Society of Western Pennsylvania, and The Institution of Mechanical Engineers. He received the Silver Medal of the Louisiana Purchase Exposition, the Elliott Cresson Gold Medal of The Franklin Institute of Philadelphia, the Willans Gold Medal of The Institution of Mechanical Engineers and The Institution of Electrical Engineers, and the ASME Holley Medal. He is credited with more than 100 patents.

ISOTOPES *as* TOOLS *of* ENGINEERING

By PAUL C. AEBERSOLD

CHIEF, ISOTOPES DIVISION, U. S. ATOMIC ENERGY COMMISSION, OAK RIDGE, TENN

IN the latter part of 1947 an Industrial Advisory Committee was appointed by the Atomic Energy Commission to survey its activities and to make recommendations for increasing industrial participation in the atomic-energy project. In its report to the Commission a year later, the Committee had the following to say about the role of industry in atomic energy:

"In only one important area is there any independent industrial activity. Radioactive and stable isotopes which the Commission is making readily available, on short notice, in reasonable quantities and at reasonable prices, are being used increasingly for industrial research and metallurgy. Their importance in helping to reveal new knowledge would be hard to overestimate."

BY-PRODUCTS OF ATOMIC ENERGY

Radioisotopes, now obtained as by-products of atomic energy, are among the most powerful and versatile tools ever placed at the disposal of research workers. When used as tracer atoms they give the scientist and the engineer a method of analysis which is more sensitive and more specific than any other physical or chemical method of analysis now known. As sources of ionizing radiation they have proved in many instances more versatile and applicable than radium or x-ray machines.

Radioisotopes are useful as tracer atoms for two reasons: (*a*) A radioactive isotope of an element will exhibit the same chemical behavior as the stable species or stable isotopes of the same element and will follow along with them in reactions and processes. (*b*) Radioactive isotopes emit radiations which will determine their identity and location. Because of these two characteristics, radioisotopes make excellent tracer atoms, that is, atoms which can be used to label their stable counterparts in elements or compounds. A specific batch of tracer atoms can be followed irrespective of the number and complexity of the reactions taking place in a system. Furthermore, no physical or chemical phenomenon can destroy their radioactive identity.

Radioactive tracer atoms have been used quite extensively in the life sciences of biology and medicine for over a decade. It has only been since the advent of the nuclear chain reactor and the inception of the Atomic Energy Commission's distribution program, however, that radioisotopes have been producible in quantities sufficient to meet the demands of all investigators regardless of their field of study. Even during the first year of the Commission's distribution program, radioisotope production was generally insufficient to meet more than the priority needs of physiologists and medical clinicians.[1] As the program has grown, production has been stepped up to a point where priority distribution is no longer necessary.

APPLICATIONS OF RADIOISOTOPES IN INDUSTRIAL RESEARCH

Accordingly, during the last two years, an increasing number of radioisotope applications have been made in industrial research laboratories. Radiomaterials have already been used as tracer atoms in investigations on such a scope of topics as friction, vulcanization, corrosion, catalysis, well-logging, detergency, diffusion, steelmaking, and so forth. More recently radioisotopes have also been used in some types of plant-control equipment.

As tools of analysis, radioisotopes may be used in at least three different ways. The first two methods, "tracer analysis" and "isotope-dilution analysis" are quantitative whereas the third, "activation analysis" may be semiquantitative, although it has usually been considered as primarily qualitative.

SIMPLE TRACER ANALYSIS

Tracer analysis is the most direct and most frequently used way of employing radioisotopes. Qualitatively the method consists of "tagging" or labeling a particular substance with the radioisotope and later determining its presence or absence in an agglomerate of other materials By using a radioactive tracer, this determination can be made quickly at concentrations far below those permitted by other methods. For short-lived materials such as radioactive sodium which loses one half of its activity in less than 15 hr, the presence of as little as 10,000 atoms or 4×10^{-19} grams can be detected. The method becomes decreasingly sensitive for longer-lived radiomaterials but even for radioactive carbon 14 which has a half life of over 5000 years, the sensitivity of detection is over a million times that of chemical methods.

In the quantitative application of simpler tracer analysis the tracer element or compound is added in known amount at one stage of a reaction or process and its concentration determined by radioactivity measurements at a later stage. One limitation of this technique is that the total amount of the material being traced must be determined accurately in the final stage of the reaction or process. This often requires time-consuming and difficult separation.

ISOTOPE-DILUTION ANALYSIS

Isotope-dilution analysis is a modification of tracer analysis. The radioactive element is mixed in known ratio with the stable form of the same element and added to the process materials. Any change in this ratio will be due to the dilution caused by the amount of that element already present in the process materials. The unknown amount of element originally present in the system is thus determined by the change in the ratio of radioactive to stable element. The advantage of this method is that it does not require quantitative chemical determination of the total amount of element. It is only necessary to measure the ratio values and these may be determined on

[1] The Atomic Energy Act of 1946 provides priority distribution of reactor-produced radioelements for use in fundamental research and medical therapy.

Contributed by the Safety Committee and presented at the Annual Meeting, New York, N. Y., November 27–December 2, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

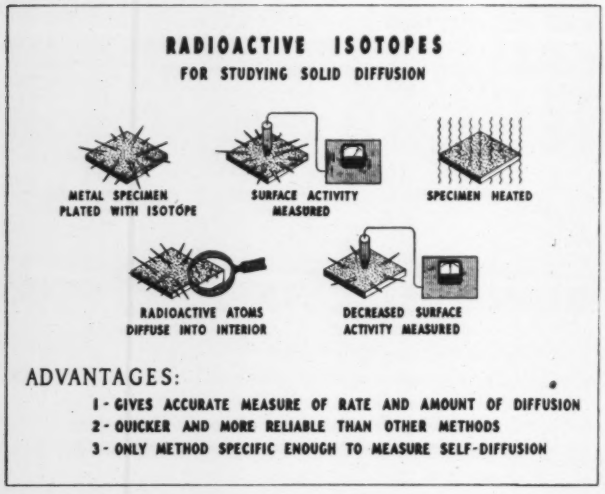

RADIOACTIVE ISOTOPES
FOR STUDYING SOLID DIFFUSION
METAL SPECIMEN PLATED WITH ISOTOPE
SURFACE ACTIVITY MEASURED
SPECIMEN HEATED
RADIOACTIVE ATOMS DIFFUSE INTO INTERIOR
DECREASED SURFACE ACTIVITY MEASURED
ADVANTAGES:
1 - GIVES ACCURATE MEASURE OF RATE AND AMOUNT OF DIFFUSION
2 - QUICKER AND MORE RELIABLE THAN OTHER METHODS
3 - ONLY METHOD SPECIFIC ENOUGH TO MEASURE SELF-DIFFUSION

FIG. 1 SCHEMATIC DIAGRAM OF HOW RADIO TRACERS ARE USED IN DIFFUSION STUDIES

unknown portions of the total material. The disadvantage of the method is that its accuracy depends on the degree of dilution which takes place; conditions should be fixed so that the dilution is neither too great nor too small.

ACTIVATION ANALYSIS

Activation analysis involves the irradiation of the unknown sample in the nuclear reactor, and the subsequent identification of the radioisotopes induced in the sample. The various radioisotopes thus produced are identified by their specific radiation characteristics. This method of analysis is mainly qualitative. It is particularly useful where the concentration of the unknown element is too low to be identified by chemical or spectroscopic methods or where standard methods of analyses are not satisfactory because of interfering contaminants. Although this is a powerful method it has certain serious limitations. A nuclear reactor or some other bombarding device is necessary for irradiating the unknown sample, the element to be analyzed may not have a suitable radiosotope for measurement, and several elements in the material may be activated which have radioisotopes with radiation characteristics so similar as to prevent their differentiation.

INDUSTRIAL APPLICATIONS

Although the radioisotope technique may at first appear to be of primary interest to the chemist or biologist, it has already proved to be extremely valuable to the chemical and mechanical engineer. Evidence of this value may be readily seen by noting a few of the industrial applications.

Carnegie Institute of Technology, General Electric Company, Massachusetts Institute of Technology, and Pittsburgh Plate Glass Company are using radioisotopes to study the diffusion of solids. The radioisotope technique because of its high sensitivity is much more easily adapted to such studies than ordinary microchemical techniques. It is the only method having the specificity to permit studies of self-diffusion.

Self-Diffusion Measurements in Iron and Cobalt. Research workers at the Metals Research Laboratory of Carnegie Institute of Technology, for instance, have used radiotracers to measure self-diffusion coefficients in both iron and cobalt. The radioactive material is plated on a disk and a measurement made of the amount of activity on the surface. The sample is then heat-treated and a second measurement made. The decrease in the amount of surface activity is a measurement of the diffusion which has taken place. As the radioactive atoms diffuse into the solid, they are replaced by inactive atoms which were formerly below the surface. The inactive atoms now on the surface absorb part of the radiation emitted by the tracer atoms, and there is a corresponding decrease in the measured radiation. The same technique can be used to measure the diffusion between both like and unlike metals. Fig. 1 shows schematically how radiotracers are used in diffusion studies.

Closely related with diffusion studies are other radioisotope applications of interest to the metallurgist and mechanical engineer such as determining the mechanisms of oxidation and crystallization, the metallurgical activity of one element as influenced by the presence of other elements, and the concentration gradients in solid solutions. By using a tracer it is possible to locate a particular constituent of a solid solution and follow its movement as the metal is subjected to various types of treatment

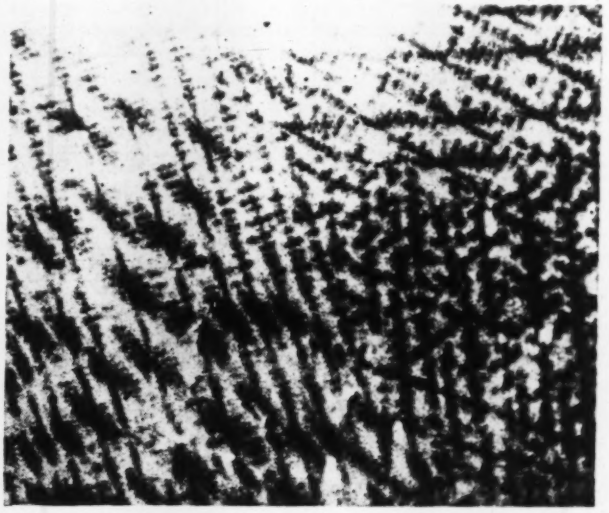


FIG. 2(*a*) AUTORADIOGRAPH OF A NI, CR, W ALLOY WITH W^{185} (Tungsten-rich areas are dark; 25 diameters. Exposure in air.)

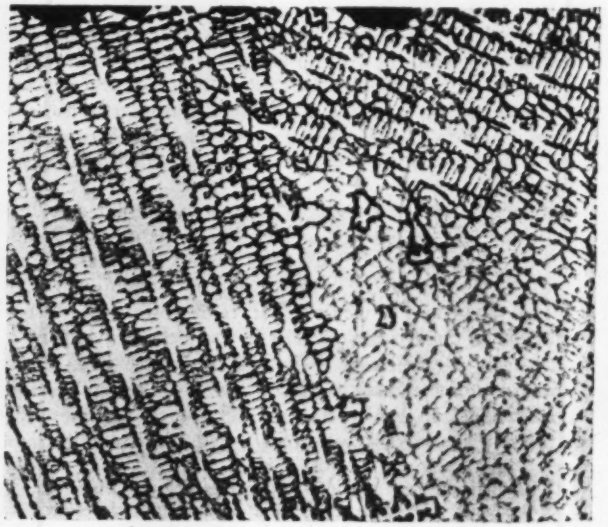


FIG. 2(*b*) PHOTOMICROGRAPH OF SAME SURFACE AS FIG. 2(*a*) [Tungsten-rich areas in Fig. 2*a* coincide with dendrites in Fig. 2(*b*).]

Locating Tungsten in an Ni, Cr, W Alloy. For example, investigators at General Electric Company have used radiotungsten 185 to determine the location of tungsten in a 70 per cent nickel, 25 per cent chromium, 5 per cent tungsten alloy. By using an autoradiograph—a picture obtained by allowing the radiations from the radioisotope in the sample to expose a photographic plate placed in contact with it—in conjunction with a photomicrograph, it was possible to show that the tungsten is located in the dendrites.

Fig. 2(*a*) shows the autoradiograph, Fig. 2(*b*) shows the photomicrograph.

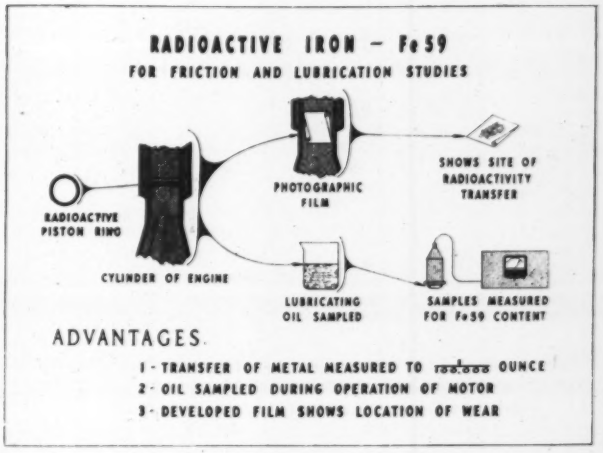
In a cobalt-base alloy, it was shown that the tungsten is generally associated with the intermetallic compounds and solid solutions between the dendrites. Although this technique gives information which cannot be obtained by other methods of analysis, its resolution has been limited by the lack of suitable photographic film. In recent months, however, fine-grain emulsions have been developed which will assure better results for this and other types of autoradiographic measurements.

Studying Friction and Wear. One of the most interesting and straightforward applications of the radioactive-tracer technique is concerned with studying the phenomena of friction and wear. Many other techniques such as the taper-sectioning method, the electrographic method and the x-ray photoraphic method have been used in such studies for a number of years. The radioisotope technique, however, is reported to be ten thousand times more sensitive for measuring the transfer of materials by friction. It also permits more detailed location of areas of wear.

In one type of friction study the California Research Corporation used radioactive piston rings in gasoline and Diesel engines. The piston rings were made radioactive by irradiation in the nuclear reactor. The rate of wear is easily followed by making periodic measurements of the radioactive iron in the lubricating oil. Because of the sensitivity of radiation detection, this method of studying wear is much more rapid than other methods. Also it is not necessary to dismantle the motor during the tests. This permits easy determination of the relative merits of various lubricating oils under exactly identical conditions. Some of the radioactive iron worn from the piston rings becomes deposited on the sides of the cylinder walls. After the experiment has been completed, the engine may again be broken down, and the detailed location of the radioactive material on the cylinder walls determined. The areas of highest activity indicate the areas of greatest wear. Fig. 3 illustrates the principle of this particular tracer application.

Other investigators are utilizing the sensitivity of the radioisotope technique to study the migration of metallic ions into insulating compounds and the mechanisms of adsorption, corrosion, surface wetting, and detergency. Because many of these phenomena often involve the transfer of materials in the range of parts per one hundred million, chemical methods of analysis are not adequate.

Studies of Oil Flow in Pipe Lines. Several of the industrial applications made of radioisotopes to date have utilized the radiomaterial primarily as a source of ionizing radiation rather than as a tracer. The California Research Corporation, for example, has found that a radioisotope makes an excellent marker for locating the boundary between two types of crude oil flowing through the same pipe line. As shown in Fig. 4, the radioactive indicator can be added just after one crude has passed through the pipe line and just as the next crude is introduced. Many miles further along the pipe line the detection of radiation on the outside of the pipe will indicate the presence of the radioactive material and the location of the boundary. This application is particularly useful when it is necessary to transport crude oils of more than one type in the same pipe line to tributaries leading to different sections of a refinery.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RADIOACTIVE PISTON RING
CYLINDER OF ENGINE
PHOTOGRAPHIC FILM
SHOWS SITE OF RADIOACTIVITY TRANSFER
LUBRICATING OIL SAMPLED
SAMPLES MEASURED FOR Fe 59 CONTENT
ADVANTAGES
1 - TRANSFER OF METAL MEASURED TO 1/10,000 OUNCE
2 - OIL SAMPLED DURING OPERATION OF MOTOR
3 - DEVELOPED FILM SHOWS LOCATION OF WEAR

FIG. 3 APPLICATION OF RADIOISOTOPE TRACER TO DETERMINE PISTON-RING WEAR

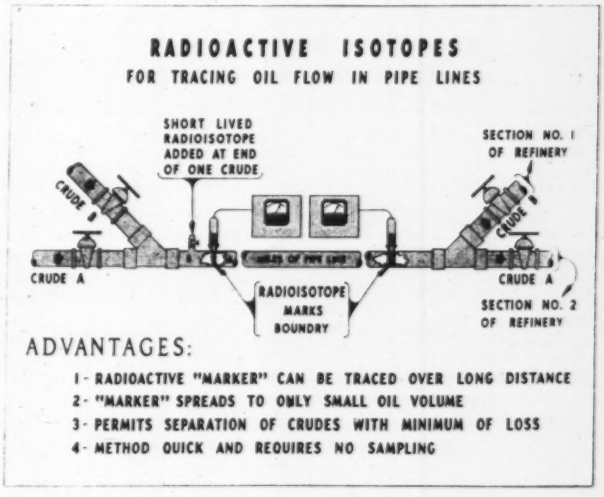
RADIOACTIVE ISOTOPES
FOR TRACING OIL FLOW IN PIPE LINES
SHORT LIVED RADIOISOTOPE ADDED AT END OF ONE CRUDE
SECTION NO. 1 OF REFINERY
CRUDE
CRUDE
CRUDE A
CRUDE A
RADIOISOTOPE MARKS BOUNDRY
SECTION NO. 2 OF REFINERY
ADVANTAGES:
1 - RADIOACTIVE "MARKER" CAN BE TRACED OVER LONG DISTANCE
2 - "MARKER" SPREADS TO ONLY SMALL OIL VOLUME
3 - PERMITS SEPARATION OF CRUDES WITH MINIMUM OF LOSS
4 - METHOD QUICK AND REQUIRES NO SAMPLING

FIG. 4 TRACING OIL FLOW IN PIPE LINES

This method of boundary marking greatly reduces wastage. In the past it has been customary, when introducing a high-grade of oil into a pipe line which had previously been used to transport a lower-grade crude, to flush several hundred barrels of the higher grade to a lower stage of the refinery in order to avoid mixing the two crudes. With the radioisotope marker the boundary between the two crudes is much more sharply defined and the costly flushing operation is unnecessary.

Radiographic Testing. A more familiar radioisotope application is found in radiographic testing. Radioactive cobalt for instance may be used in the radiographic examination of welds and castings in the same way that radium sources and x-ray machines have been employed for many years. Because cobalt can be machined to any desired shape and size before being made radioactive in the nuclear reactor, it has been found to be somewhat more versatile in its application. Sources of this radioisotope can be prepared which have a gamma-ray output per unit weight several times that of radium. It is also possible to obtain at lower costs radiocobalt sources having total activities many times greater than available radium sources.

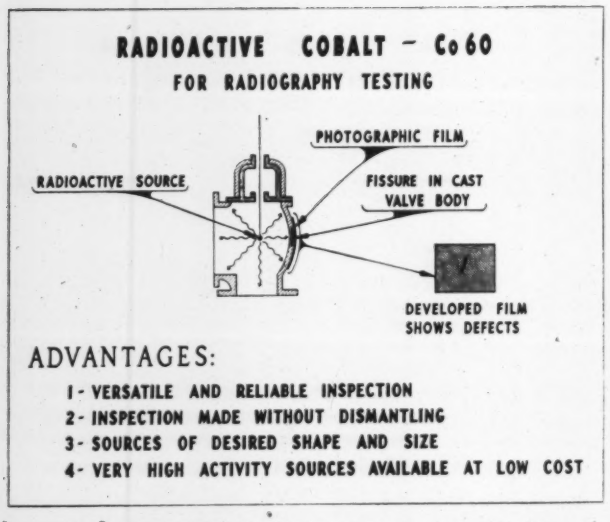
RADIOACTIVE COBALT - Co 60
FOR RADIOGRAPHY TESTING
PHOTOGRAPHIC FILM
RADIOACTIVE SOURCE
FISSURE IN CAST VALVE BODY
DEVELOPED FILM SHOWS DEFECTS
ADVANTAGES:
1 - VERSATILE AND RELIABLE INSPECTION
2 - INSPECTION MADE WITHOUT DISMANTLING
3 - SOURCES OF DESIRED SHAPE AND SIZE
4 - VERY HIGH ACTIVITY SOURCES AVAILABLE AT LOW COST

FIG. 5 RADIOGRAPHIC EXAMINATION OF A CAST VALVE

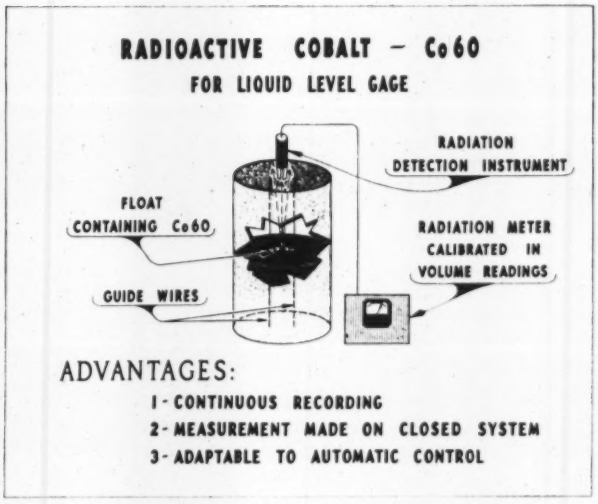
RADIOACTIVE COBALT - Co 60
FOR LIQUID LEVEL GAGE
RADIATION DETECTION INSTRUMENT
FLOAT CONTAINING Co 60
RADIATION METER CALIBRATED IN VOLUME READINGS
GUIDE WIRES
ADVANTAGES:
1 - CONTINUOUS RECORDING
2 - MEASUREMENT MADE ON CLOSED SYSTEM
3 - ADAPTABLE TO AUTOMATIC CONTROL

FIG. 6 RADIOISOTOPE ADAPTED TO HEIGHT GAGE

For radiography testing of thin and low-density materials, other radioisotopes with less penetrating radiation may prove useful. Fig. 5 illustrates the use of a radioisotope in making a radiographic examination of a cast valve.

Application to Gages. The radioisotope application which at present holds the most promise for the process engineer is the control or "gadget" type. Foremost of these are the radioactive height gage, and the radioactive thickness gage. Here again the radioisotope is used only as a source of radiation. For example, a radioisotope may be adapted to a height gage as shown in Fig. 6. In this instance the radioactive source is placed in a float which rides on the surface of the liquid whose level is to be determined. As the level of the liquid rises, the source comes closer to the radiation-detection instrument mounted on top of the vessel containing the liquid, and there is a corresponding increase in the amount of measured radiation.

Measuring Height of Liquid Steel in Cupola. The Ford Motor Company has used a variation of the radioactive height gage to get an approximation of the height of liquid steel in cupolas. As used in this particular application the radioactive source is mounted on the outside of the cupola and the radiation-detection instrument is mounted at the same height on the opposite side. The gamma radiation from the radiocobalt source is directed to pass through the cupola to the detector. When the level of the molten steel rises above the height of the source, part of the radiation is absorbed and there is a marked decrease in the measured radiation. This gage is particularly well-suited for this purpose because it can be operated from outside the cupola and is not affected by the ambient high-temperature heat.

Radioactive Thickness Gage. The radioactive thickness gage was developed shortly after the inception of the Commission's distribution program. Investigators at the Goodyear Rubber Company, one of the first groups to work on this application, developed a gage using radioactive carbon 14 to measure the thickness of a thin rubber material called pliofilm. Since that time other radiomaterials have been incorporated into similar gages designed to measure the thickness of sheet paper, glass, and steel. Two companies, Tracerlab, Inc., and General Electric Company, are now making radioactive thickness gages for commercial distribution. All of the gages, as shown schematically in Fig. 7, are based on the fact that the amount of radiation transmitted through a sheet of material is inversely proportional to the thickness of the sheet.

Radioactive thickness gages are more advantageous than other devices designed for this purpose because they give

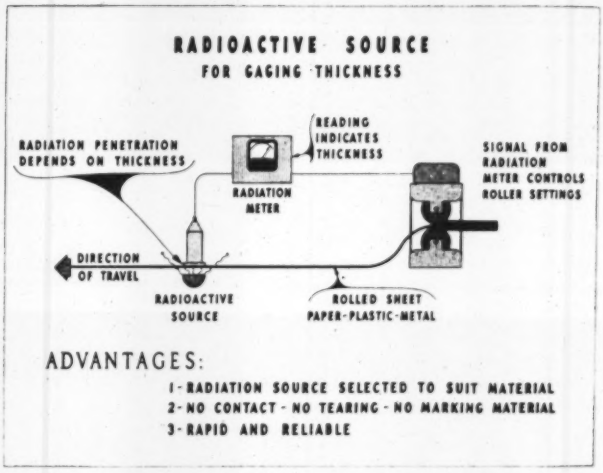
RADIOACTIVE SOURCE
FOR GAGING THICKNESS
RADIATION PENETRATION DEPENDS ON THICKNESS
READING INDICATES THICKNESS
RADIATION METER
SIGNAL FROM RADIATION METER CONTROLS ROLLER SETTINGS
DIRECTION OF TRAVEL
RADIOACTIVE SOURCE
ROLLED SHEET PAPER-PLASTIC-METAL
ADVANTAGES:
1 - RADIATION SOURCE SELECTED TO SUIT MATERIAL
2 - NO CONTACT - NO TEARING - NO MARKING MATERIAL
3 - RAPID AND RELIABLE

FIG. 7 GAGE FOR MEASURING THICKNESS

measurements without mechanical contact or without stopping or cutting the rolling sheet. Because no mechanical contact is necessary, such gages can also guarantee measurements of greater sensitivity and higher precision and eliminate possibilities of ripping or tearing the sheet. They can also be operated by nontechnical personnel and are adaptable to automatic control of the roller settings.

Only a few of the present radioisotope applications in industry have been illustrated but they are representative of the type which may be of most interest to mechanical engineers.

SPECIAL TECHNIQUES USED IN HANDLING AND APPLYING RADIOACTIVE MATERIALS

No mention has been made of the special techniques required in handling and using radioactive materials. Because reactor-produced materials like naturally occurring radioactive materials produce radiations which are potentially hazardous to health, special techniques as well as special facilities to minimize these hazards are required. This phase of their utilization is covered in a companion paper.[2]

(*Continued on page 1031*)

[2] "Safe Handling of Radioisotopes," by G. G. Manov and D. O. Lintz, presented as a companion paper at the Annual Meeting, New York, N. Y., November 27–December 2, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

SAFE HANDLING *of* RADIOISOTOPES

By G. G. MANOV[1] and D. O. LINTZ[2]

ISOTOPES DIVISION, ATOMIC ENERGY COMMISSION, OAK RIDGE, TENN.

INTRODUCTION

THE radioactive by-products of atomic energy, "radioisotopes," will play a great part in the future of many industries. A companion paper by Dr. Aebersold (1)[3] presents some of the uses and the limitations of radioactive materials in the field of engineering and technology. At the same time, the widespread use of such radioisotopes will add another potential health hazard requiring special consideration for its control. Hazards have arisen in industries in the past and have been appraised and controlled properly. Although the protection from the dangers of radiation is unlike the majority of problems usually encountered in most industry, there is no apparent reason why it cannot be as equally well managed.

The scope of this presentation is confined to the safe handling of radioisotopes. Information regarding the availability of radioisotopes, and their application to research and industry is available elsewhere (2, 3). The materials distributed by the Atomic Energy Commission are confined to radioactive substances emitting beta and/or gamma rays (with the exception of one alpha and one neutron source).

Radiologists have used x rays since approximately 1893, but not without harm to themselves, because the danger to which they were being subjected was not fully recognized. Man does not possess a special sense which will notify him of radiation hazard as will his sense of touch indicate to him whether an object is hot or cold. Because of this sensitory lack, he must rely upon other means, such as radiation-detecting instruments, to warn him of the presence of this "ghost-like" danger.

PRELIMINARY CONSIDERATIONS

Radioisotopes can be handled just as safely as are electricity, dangerous chemicals, and explosives, if the necessary, although different, precautions are taken. Present laboratory and industrial uses of radioisotopes involve amounts of active materials which are many powers of ten less than those employed within the Atomic Energy Commission installations. It may be said at once that most of the precautionary measures employed in the safe handling of radioisotopes in the two cases are alike in principle except for the scale on which they are used. Most laboratory applications will involve working with active materials in the microcurie and millicurie level. In the case of the former, the precautions to be followed are those normally employed in any well-managed chemical, physical, or mechanical-engineering laboratory, with the addition of special techniques (described later) to insure protection against hazards created by radiation and by spillage contamination within the laboratory by active isotopes.

Millicurie or multimillicurie levels require, in addition some type of shielding and possibly some forms of remote-control apparatus. Operations involving many curies of activity are not to be encountered in industrial applications in the near future except possibly in such forms as nuclear-energy engines. Mechanical engineers will play an important part in the design and improvement of remote-control handling equipment for such installations.

The Atomic Energy Commission has long realized the need for assisting others in their initial use of radioisotopes and has established under the Isotopes Division an Advisory Field Service Branch staffed with qualified personnel. Assistance is offered by means of publications and by field visits to existing or proposed installations in the design of laboratories, the safe handling of radioisotopes, the disposal of unwanted material, the standardization of measurements, and health-physics monitoring and supervision.

Suitable protection against excessive radiation can be provided by appropriate combinations of several factors such as the following:

1 Maintaining proper *distance* between the radioactive source and the user which, by application of the inverse square law (applicable in most cases), will be sufficient to reduce the radiation intensity to a permissible level;

2 Limiting as much as possible the *time* during which the isotope is handled;

3 Utilizing the proper *shielding* between the source and the user. Applicable shielding materials may range from Lucite sheets for isotopes emitting only beta rays (particles), to massive blocks of lead or concrete for intense sources that emit gamma rays as well. In either case, the thickness and type of shielding will depend upon the nature and the quantity of the isotope employed;

4 Suitably planning the experiment to use the *minimum quantity* of radiomaterial required for an unequivocal answer to the problem under investigation;

5 Limiting *stray radiation* associated with spread of contamination from spills of radioactive material. Considerable effort and constant vigilance are necessary to reduce to a permissible level this type of radiation hazard.

TYPES OF RADIATION[4]

Alpha particles such as those obtained in the disintegration of radium, for example, are doubly ionized helium atoms. In so far as detection is concerned, they are characterized by their relatively short range in air (a few centimeters), and their intense ionizing power. *Beta* particles, for example, those emitted from radiophosphorus, are high-speed negatively

[1] Chief, Advisory Field Service Branch, Oak Ridge Operations Office.

[2] Health Physicist, Advisory Field Service Branch, Oak Ridge Operations Office.

[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Safety Committee and presented at the Annual Meeting, New York, N. Y., November 27–December 2, 1949, of The American Society of Mechanical Engineers.

[4] No attempt is made in this paper to present in detail the nature of radioactive changes. For additional information, reference is made to standard textbooks.

charged electrons and are ejected during the course of radioactive decay, with energies varying in a continuous spectrum from zero to a maximum value that is characteristic for each isotope. Most beta particles can be stopped with a few centimeters of aluminum or other absorber. Because of the ionization produced by beta particles as they pass through a medium, it is possible to detect their presence with a suitable ionization chamber.

The negatively charged beta particle has a counterpart, the *positron*, which carries a positive charge. Absorption of the positron (from the decay of Na^{24}, for example) is always accompanied by two gamma rays, each of 0.51 Mev in the form of annihilation radiation. When a beta particle passes very close to the nucleus of an atom, it may have sufficient energy to eject or radiate a *photon*. This process results in *Bremsstrahlen*, which are emitted when the charged beta particles are decelerated rapidly at the end of their path. *Gamma* rays, unlike beta particles, travel with the velocity of light and have no mass. Low-energy or "soft" gammas are stopped by about $^1/_2$ in. of lead, while high-energy or "hard" gamma rays produced by some radioactive atoms can penetrate several inches of this absorber. Gamma rays are absorbed exponentially, and are detected indirectly by the ionization produced by the electrons which are ejected from the material through which the gamma rays are passing. For equal energies, gamma rays have approximately 100 times the penetrating power of beta particles.

The *neutron* is an uncharged particle with a mass that is essentially equal to that of a proton. Neutrons produce no primary ionization per se but in colliding with charged nuclei, energy is imparted to the latter, which in turn produces ionization that is detectable.

Beta rays have a maximum range commensurate with their maximum energy; gamma rays have no definite range, but their intensity is reduced exponentially with increasing thickness of absorber. In Fig. 1 are shown the relative penetrating

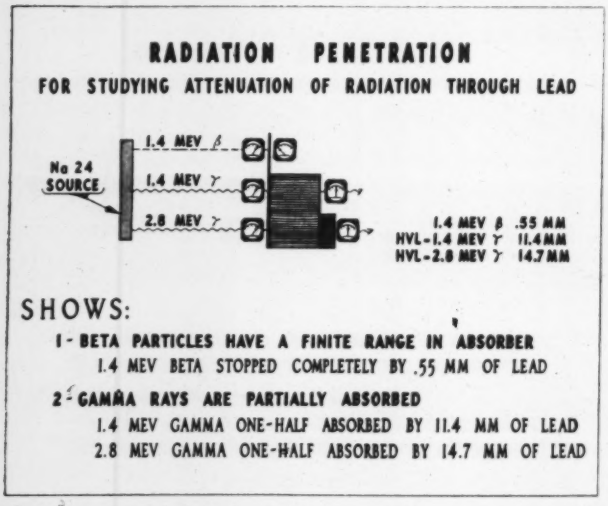
RADIATION PENETRATION
FOR STUDYING ATTENUATION OF RADIATION THROUGH LEAD
Na 24 SOURCE
1.4 MEV β
1.4 MEV γ
2.8 MEV γ
1.4 MEV β .55 MM
HVL-1.4 MEV γ 11.4 MM
HVL-2.8 MEV γ 14.7 MM
SHOWS:
1 - BETA PARTICLES HAVE A FINITE RANGE IN ABSORBER
1.4 MEV BETA STOPPED COMPLETELY BY .55 MM OF LEAD
2 - GAMMA RAYS ARE PARTIALLY ABSORBED
1.4 MEV GAMMA ONE-HALF ABSORBED BY 11.4 MM OF LEAD
2.8 MEV GAMMA ONE-HALF ABSORBED BY 14.7 MM OF LEAD

FIG. 1 CHARACTERISTICS OF BETA AND GAMMA RADIATIONS

abilities of beta and gamma radiations. Na^{24} was chosen as a convenient example because it emits both beta and gamma rays. It should be noted that the beta rays from Na^{24} are completely stopped by 0.55 mm of lead as indicated by the meter in Fig. 1, whereas to reduce by one half the intensity of the gamma rays of equivalent energy, 11.4 mm of lead are required. The "half-value layer" shown here is defined as that thickness of a particular material which will reduce the initial radiation intensity by one half.

THE PERMISSIBLE DOSE

Various terms such as "safe," "tolerance," and "permissible" are used throughout the literature to describe low-intensity doses received by the body. Man has been subject since birth to bombardment by cosmic rays whose intensities increase with increasing altitude. In theory, the radiation from isotopes should be reduced to that of the cosmic ray and other background intensity in order to be considered "safe," in the sense of not exceeding that which would be absorbed were the artificial radioactivity absent. A "tolerable" dose might be defined as that from which the body might be expected to recover without permanent damage. Since the quantity of radiation which is tolerable is not known with certainty, there has arisen the term "permissible dose" whose connotation is that its maximum value is subject to revision in the light of subsequent experiments.

Historically the establishment of the "maximum permissible dose" extends back to the year 1896, when the first case of X-radiation damage was described. Early experimental work was confined primarily to the skin, but tests conducted on blood-forming tissues and reproductive organs of animals gave warning that far greater damage than mere dermatitis could be anticipated. It was found that a given quantity of radiation delivered to the whole body was much more dangerous than if the same quantity were delivered to a small area. In 1928 more careful consideration was given to the maximum permissible dose. The U. S. Advisory Committee on X-Ray and Radium Protection suggested (4) in 1931, that the maximum dose be set at 0.2 roentgen (r) per day (defined later), as did the International Committee on X-Ray and Radium Protection in 1934 (5). In 1936 the former body revised the value downward (6) to 0.1 r per day. The value of 0.1 r (or 100 mr) per day, which has been used since 1936 in the United States in connection with x rays and gamma radiation, has recently been reaffirmed (7).

There is now some belief (8) that this value should be reduced to 300 mr per week, for animal experimentation and examination of persons damaged with x rays indicate that 100 mr per day can be too high. Recently several subcommittees of the National Committee on Radiation Protection have recommended that the maximum level of permissible external radiation be limited to the following (9):

1 0.300 rep (radiation dosage units) per week of beta and/or gamma radiation (6.25 mr per hr for a 48-hr work week);

2 1.0 rep per week if exposure were limited to the hands;

3 25 rep per single exposure to a man 21 years of age or over, provided assurance is taken that he receives no further exposure before the age of 45;

4 50 rep per single exposure to a man 45 years of age or over, provided assurance is taken that he receives no further exposure during his lifetime. However, a person who received a single exposure of 25 rep before reaching the age of 45 could be permitted a subsequent single exposure of 25 rep;

5 0.03 rep of fast neutrons per week.

For the purpose of visualizing orders of magnitude, it might be noted that an x ray of the chest involves an exposure of approximately 1 r; a prolonged series of exposure confined to the intestinal tract, for example, may involve 15 to 20 r. However, a series of x-ray treatments to a surface cancer may correspond to several thousand r. Man is much more susceptible to radiation if it is delivered to the whole body rather than to an area or an extremity. The present permissible limit of 0.3 r per week represents a value which is considered to be well below that necessary to cause any temporary or permanent

TABLE 1[a] SOME HEALTH PHYSICS SURVEY METERS[b]

Instrument	Weight, lb	Size, in.	Radiation detected	Usual accurate sensitivity range, mr/hr[c]	Most useful purpose
Lauritsen electroscope	8	8 × 3 × 14	Beta, Gamma	0.1 to 1000	Measuring dosage rates. Instrument response too slow for measuring low activity contamination.
Portable Geiger-Mueller instruments	2–15	7 × 5 × 4 (average)	Beta, Gamma	0.1–15 to 20	Detecting surface contamination. (Low-energy beta particles can be detected with suitable thin-walled tubes.)
"Cutie Pie" meter	4	12 × 3 × 8	Beta, Gamma	10–5000	Measuring dosage rates.
Zeus	10	12½ × 6½ × 5	Beta, Gamma	5–5000	Measuring dosage rates.
Commercial model of Zeuto	6	9½ × 5 × 6	Beta, Gamma (Alpha)	0.1–40	Measuring dosage rates. Detecting surface contamination.
Juno meter	5	9 × 5¼ × 4	Beta, Gamma (Alpha)	5–4000	Measuring dosage rates.
Scaler (G-M tube on cable)	40–100	21 × 15 × 10½	Beta, Gamma	0.1–15 to 20	Detecting surface contamination. (Low-energy beta particles can be detected with suitable thin-walled tubes.)

[a] References: (14) *Nucleonics* 4, March, 1949, p. 26.
[b] The inclusion or exclusion of specific instruments in this table does not necessarily endorse or disapprove their use.
[c] D. M. Davis. "Health Physics Instrument Manual," Health Physics Dept., O. R. N. L.

changes in humans. Experimental evidence indicates that mutations caused by radiation are usually recessive in character and, providing the intensity is maintained below the permissible level, there is no need for undue concern regarding such effects.

The effect of low-dosage radiation in shortening the span of life has been estimated from work in animals to be approximately 0.01 per cent per roentgen of total body radiation received at a uniform rate over the life of the subject. If one assumes the Biblical span of threescore and ten, the figure corresponds to 7×10^{-3} years per r or approximately 2.5 hours per roentgen received from the time of birth.

A continuous dose of 0.3 r per week received from the age of 21 to the age of 70, for example, would probably shorten the life expectancy by about 3 months. The chances of premature expiration because of radiation hazard, *provided* adequate safety precautions are employed are, therefore, very small compared to the possible effects at the age of 70 of hardening of the arteries, cancer, heart disease, traffic accidents or falls, or overindulgence.

It can be seen, therefore, that the limit of 0.3 r per week is a conservative one.

DOSAGE UNITS

There are three commonly defined units of radiation (10), as follows:

1 The roentgen (r), defined as that quantity of x or gamma-radiation such that the corpuscular emission per 0.001293 grams of air (1 cc) produces in air ions carrying 1 esu of electricity of either sign;

2 The roentgen equivalent physical (rep), that quantity of ionizing radiation which is capable of producing 1.61×10^{12} ion pairs per gram of tissue, or that will be absorbed in tissue to the extent of 83 ergs per gram (10);[5]

3 The roentgen equivalent man (rem), defined as that quantity of energy absorbed in tissue which is biologically equivalent in man to one roentgen of x or gamma-radiation;

In Table 2 are given the maximum permissible dosages to be used at the Oak Ridge National Laboratory after 1949, for various types of radiation.[6] It should be noted that beta and gamma radiation present essentially the same hazard, but that alpha particles (taken internally) and fast and thermal neutrons are considerably more dangerous. The last three types of radiation find virtually no application outside of the laboratories of the Commission.

[5] This value has recently been revised (8) to 95 ergs per gram of tissue.
[6] We are indebted to Dr. Karl Z. Morgan for this information which is to be published as Chapter VI in a forthcoming "Handbook on Nuclear Instruments and Techniques."

DETECTION OF RADIATION

Survey Instruments. There are two main types of radiation survey and monitoring instruments: Those such as a Geiger-Mueller (G-M) counter which respond to a single ionizing event, and those which indicate the continuous dissipation of energy as in an ionization chamber. G-M counters are very sensitive and are suitable for quick measurement of low activities. Ionization chambers are not as sensitive, but have a greater range of measurement and are less energy-dependent (11).

In Fig. 2 are shown a number of survey instruments based on the principle of the ionization chamber. The extended chamber on the instrument in the foreground is for the purpose of reading over barriers, through holes, and around corners without subjecting the operator to undue radiation.

In Table 1 are given some of the characteristics of a few health-survey meters.

Personnel Monitoring. Routine personnel monitoring is accomplished by using one or more of the following detection devices shown in Figs. 3 and 4.

In Fig. 3 are displayed (from left to right) wrist, necktie, and finger film badges, a standard type of film badge, and two pen-type pocket meters.

A closer view of the third-named type of badge, as developed by the Oak Ridge National Laboratory, is shown in Fig. 4, and consists of a radiation-sensitive film enclosed in an expendable plastic ring which is adjustable to any size finger. One of the adjustable arms is perforated so that a pin can be inserted if desired and the ring pinned to any part of the clothing. In the illustration shown, the ring is attached to the sleeve of a laboratory coat with a safety pin. The ring and film are used only once and the latter is developed to determine the dosage received. It is of considerable advantage to a worker to be able to measure the total dosage to which his hands have been subjected during an experiment, and this use of a film badge also serves to revise techniques, the working distance, and the amount of radioactive materials that can be handled safely.

Analysis of the film badges at the Oak Ridge National Laboratory where, in some cases, hundreds of thousands of millicuries of radioactivity are processed, show that the protective measures are so complete that on the average 98 per cent of the workers receive only one fifth of the permissible dosage per

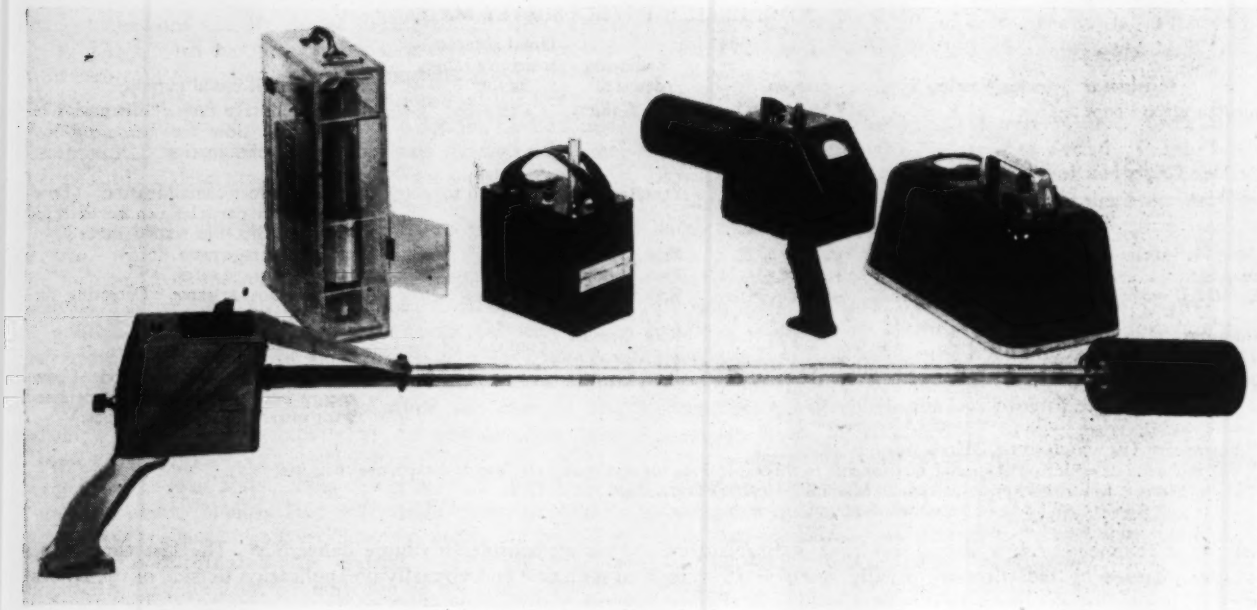

FIG. 2 TYPICAL GROUP OF SURVEY INSTRUMENTS USED FOR RADIATION DETECTION

(Reading from left to right: Extended chamber "cutie pie"; Lauritsen electroscope; L & W electroscope; ordinary "cutie pie"; and a Zeus See Table 1 for operating characteristics and range of measurements.)

TABLE 2 VALUES OF MAXIMUM PERMISSIBLE EXPOSURE TO BE USED AT OAK RIDGE NATIONAL LABORATORY AFTER 1949[a]

Type of radiation	mr/wk	mrep/wk	mrem/wk	Approximate flux for a 24-hr exposure[b]
X or gamma rays	300	...	300	1200 photons of 1 Mev/cm² sec
Beta rays	...	300	300	32 electrons[c] of 1 Mev/cm² sec
Thermal neutrons	...	60	300	410 n_t of 0.02 ev/cm² sec
Fast neutrons	...	30	300	22 n_f of 2 Mev/mcm² sec
Alpha rays	...	15	300	0.0017 alphas of 5 Mev/cm² sec

[a] We are indebted to Dr. Karl Z. Morgan of the Oak Ridge National Laboratory for this information.

[b] Values of flux corresponding to 60 mrem/day for an exposure of five workdays per week.

[c] About one half this value is used for beta rays with a normal energy distribution ranging from zero to a maximum energy of 1 Mev.

week. Occasionally the radiation may arise from an internal source; in case of entry into the body of active materials (by eating or drinking under improper conditions), irradiation will be from within where control is impossible. One must then rely upon the natural rate of elimination of the radioisotope by the body.

Medical examinations of workers with respect to blood count are made routinely. The cumulative effects of excessive exposure (which is usually caused by disregard of safety rules) can be detected by changes in the count and the worker transferred to other operations until the blood picture becomes normal. It is entirely possible to detect such changes long before permanent damage is done.

LABORATORY HANDLING OF RADIOISOTOPES

Proper detecting instruments, along with adequate laboratory equipment and good common-sense techniques make for nonhazardous employment of radioisotopes. The use of some of these techniques will be mentioned.

Distance is one safe "tool" or technique that can be employed readily by all users. Although it is the most economical form of protection against radioactive hazards, there is a limit to the working distance that can be used commensurate with the retention of dexterity of operation. In such cases, recourse may be had to remote-control handling equipment.

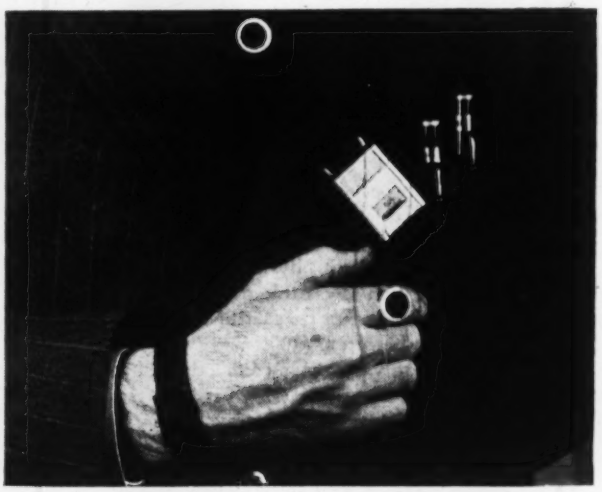

FIG. 3 TYPICAL PERSONNEL MONITORING DEVICES

(Reading from left to right: 1, Film rings, on wrist, necktie, and finger, which are composed of a radiation-sensitive film enclosed in electricians' tape; 2, standard-type film badge containing, *a*, cadmium shield, *b*, lighttight shield, upper portion measures the gamma, and lower portion measures both beta and gamma; 3, two pen-type pocket meters whose loss of charge is read daily to indicate exposure to radiation.)

FIG. 4 CLOSE-UP VIEW SHOWING TYPICAL USAGE OF FILM RING TO DETERMINE DOSAGE RECEIVED IN CLOSE HANDLING OF RADIOISOTOPES

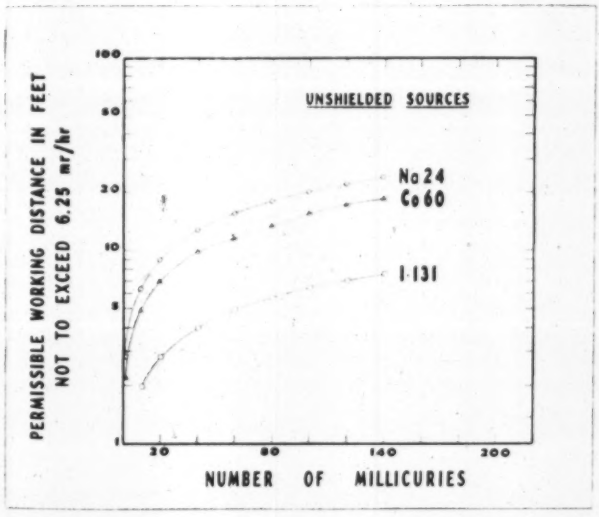

FIG. 5 PERMISSIBLE WORKING DISTANCE IN FEET—GAMMA RADIATION INTENSITY NOT TO EXCEED 6.25 MR PER HR, FOR VARIOUS QUANTITIES OF UNSHIELDED SOURCES OF NA^{24}, CO^{60}, AND I^{131}

(For a given quantity of radioisotope, permissible working distance *a* should be increased slightly at shorter distances because of beta radiation, and *b* should be decreased slightly at longer distances, i.e., beyond beta range, because of partial absorption of gamma radiation by air. Average range in air of beta particles from Na^{24}, I^{131}, and Co^{60}, are 3, 1, and 0.3 ft, respectively. Gamma radiations are each absorbed approximately 5 per cent at maximum distances shown in graph. Major protection against total radiation is afforded by inverse square law.)

In Fig. 5 is presented graphically the concept of distance as a working tool. The curves show the permissible working distance in feet as a function of the number of millicuries in unshielded sources of Na^{24}, Co^{60}, and I^{131}. The maximum permissible dose is assumed to be 6.25 mr per hr. One must not rely entirely upon calculation, but should check with a reliable survey instrument to determine the dosage rate received from a radioisotope under the conditions of use.

Another very important safety tool is control of the *time* of exposure. This factor can be varied according to the hazard and if the intensity of radiation is high, the time spent in the working field may have to be limited to minutes or seconds.

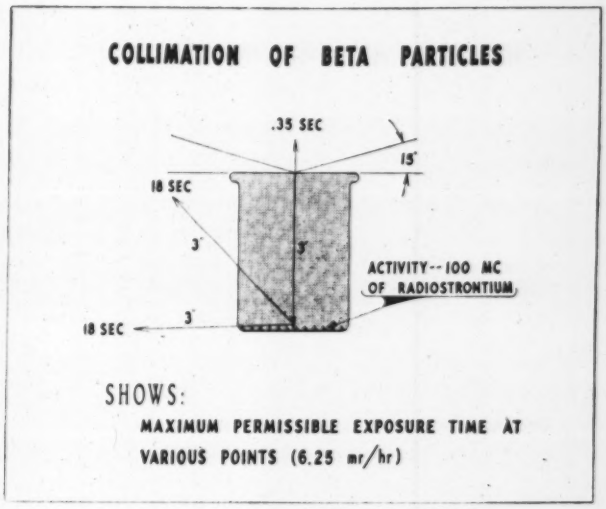

FIG. 6 PERMISSIBLE WORKING TIME IN SECONDS AT DISTANCE OF 3 IN. FROM SOURCE OF 100 MC OF RADIOACTIVE STRONTIUM CONTAINED IN A PYREX BEAKER

(Danger of peering into top of beaker as compared to a view through side is often overlooked.)

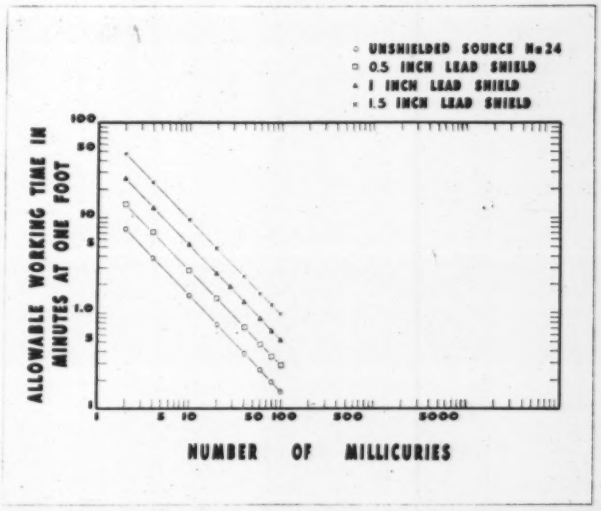

FIG. 7 APPROXIMATE PERMISSIBLE WORKING TIME IN MINUTES WITHIN 1 FT OF VARIOUS QUANTITIES OF NA^{24} (*a*) UNSHIELDED, (*b*) SHIELDED, WHICH WILL NOT INVOLVE ABSORPTION OF A DOSE GREATER THAN 6.25 MR DURING TIME OF EXPOSURE

In Fig. 6 is illustrated permissible working time for handling of 100 millicuries of radioactive strontium. This material is a mixture of isotopes ranging from strontium 89, with a half life of 55 days and with a beta energy of 1.5 Mev; strontium 90, with a half life of approximately 30 years and with a beta energy of 0.7 Mev; and yttrium 90, with a half life of 62 hr and with a beta energy of 2.16 Mev. The radiation intensity is more than 50 times as great above the beaker as at a comparable distance outside of the beaker. The example is given because it illustrates conditions frequently met in radiochemical laboratories in that the radiation from the side of the container may be comparatively harmless, whereas an object such as a hand, held over the top of the beaker will receive comparatively serious radiation injury.

Shown in Fig. 7 are the amounts of time that can be spent

TABLE 3 TYPICAL SHIELDING REQUIREMENTS FOR 10 MC OF VARIOUS ISOTOPES

Isotope	Intensity of unshielded 10 mc source at 1 ft distance[a]	Gamma energy, mev		Thickness of lead shielding required to reduce gamma-ray intensity at 1 ft distance: To one-half unshielded intensity	To tolerance level of 6.25 mr/hr
I 131	25 mr/hr	0.638	(15%)	0.6 cm	1.1 cm
		0.364	(79%)		
		0.284	(6%)		
		0.080			
Co 60	148 mr/hr	1.16	(100%)	1.1 cm	5 cm
		1.30	(100%)		
Na 24	249 mr/hr	1.38	(100%)	1.5 cm	8 cm
		2.76	(100%)		

[a] Gamma radiation only.

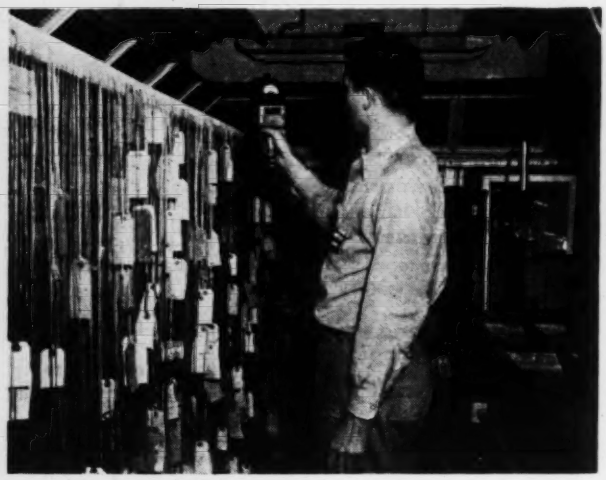

FIG. 8 HEALTH PHYSICIST CHECKING INTENSITY OF RADIATION FROM ISOTOPES WHICH ARE BEHIND A TYPICAL HIGH-LEVEL STORAGE "CAVE"

(Instrument being used is the "cutie pie" shown in Fig. 2. Hundreds of millicuries of radioisotopes may be kept in such caves with safety.)

FIG. 9 TYPICAL EXAMPLE OF A TRANSPARENT SHIELD FOR USE WITH PURE BETA-EMITTING ISOTOPES

(Lucite is of sufficient thickness to stop beta particles completely without production of excessive secondary radiations known as Bremsstrahlung. This type of shield can be used also for assembly of small, irradiated mechanical parts.)

within 1 ft of various quantities of unshielded Na^{24} without exceeding the maximum permissible intensity of 6.25 mr per hour. Fig. 7 also indicates how the available working time can be increased by using various thicknesses of lead as a shielding material.

The *amount* of radioactive material used is another factor which can be controlled and thus make for safe handling. If of necessity, this amount is sufficient to present a radiation hazard, then another factor can be introduced—that of proper shielding.

Typical Shielding Requirements. Shielding requirements will depend upon the type of experiment and the type of radiation to be shielded. Beta particles of low energy, such as those from C^{14}, S^{35}, or Ca^{45} are stopped by the ordinary glassware or plastic containers used in a chemistry laboratory. More energetic particles will require a few millimeters of plastic or aluminum.[7] Gamma rays are very penetrating and may require several inches of lead or any other dense material to reduce the radiation to a permissible level of 6.25 mr per hr. An excellent discussion of the problem is given by G. W. Morgan (12).

Calculation of Shielding. Gamma rays do not have a maximum range in an absorber, but are merely absorbed exponentially in passing through the medium. The degree of absorption can be calculated by the use of the equation

$$I = I_0 e^{-\mu t} \quad [1]$$

where I and I_0 are the final and initial intensities, μ is the linear absorption coefficient, and t is the thickness of the absorber. The thickness of any material which is required to reduce the intensity of gamma radiation by one half is called a half-value layer (hvl). This thickness (hvl) will vary with the energy of the gamma ray for different materials and is directly proportional to the number of the electrons per cubic centimeter in the absorbing medium.

Typical examples of the shielding requirements for 10 mc quantities of I^{131}, Co^{60}, and Na^{24} are given in Table 3.

When working with multicurie levels of beta and gamma emitters, extensive shielding is required. In Fig. 8 is shown a typical high-level storage "cave." The scientist from the Health Physics Department of Oak Ridge National Laboratory is checking the intensity of the radiation with an ionization chamber called a "Cutie Pie." A string is attached to each container of radioisotopes to facilitate its removal without endangering the operator. The mirrors in the back of the cave are used to assist in placing samples into the vault without the operator having to get up and peer over the top of the shield. The individual making the survey would be in danger of serious radiation damage if the shield of lead did not exist

[7] One of the anomalies encountered is that a small amount of shielding (and in particular, lead shields) against beta radiation is sometimes more dangerous than no shielding at all. The absorption of beta particles produces secondary radiation called Bremsstrahlung (13) which is more penetrating than the primary radiation. This effect is diminished if shielding of low-atomic-number (aluminum, etc.) is used.

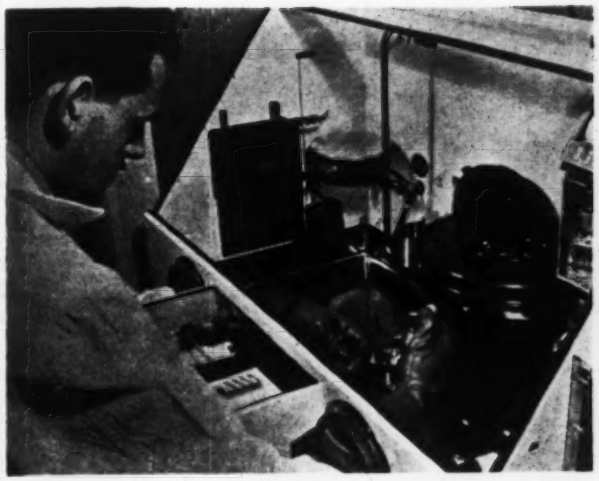

FIG. 10 AIRTIGHT, GLASS-FRONT GLOVE BOX IS USED FOR LOW-ENERGY BETA-EMITTING ISOTOPES WHICH PRESENT HAZARD FROM DUSTING OR FROM VOLATILIZATION

(With the use of lead-lined gloves, low-energy gamma emitters may be handled as well as beta emitters. Necessary manipulations can be performed by placing hands in long gloves. This type of box can be adapted for use with high-energy gamma emitters by addition of remote-control devices and heavy lead-glass window.)

Millicurie levels of pure beta emitters, such as P^{32}, can be handled with complete safety from radiation in shields of transparent plastic as shown in Fig. 9. While the illustration relates primarily to the manipulation of an active culture, it is obvious that this type of apparatus can be used for the assembly of small mechanical parts which have been irradiated. Plastic shields (close shielding) can be constructed for beakers, flasks, graduated cylinders, and test tubes, as well as other apparatus. The transparency of certain plastics makes them ideal for shields of this type.

Microcurie levels of low-energy beta or gamma emitters which are highly radiotoxic if taken into the body are handled in a gloved box, Fig. 10. Such boxes contain all the apparatus necessary for carrying out the chemistry and other steps in the experiment and prevent the spread of the activity into the air breathed by the worker. The activity is usually sealed in an airtight container before removal from the box.

Typical Manipulations. There is at present little expectation that multicurie sources of radioisotopes will be used outside of the Commission facilities. When the status of the development of power piles necessitates the use of large quantities of activity, it will be the task of mechanical, electrical, and other engineers to design suitable remote-control devices. One of these developed by Mr. John Payne of General Electric Company is shown in Fig. 11. A system of "master-slave" electrical motors is used to perform such operations as pouring a liquid from one vessel into another, titrating acids with bases, opening sealed cans, and so forth. In actual practice, the sheet of glass shown in Fig. 11 is replaced by a lead or concrete wall of appropriate thickness, and the operations are viewed through a periscope or other suitable arrangement of mirrors.

Improvements are now existent which also possess the rudiments of a sense of "touch." In assembling a series of parts held together by a bolt and nut, for example, it is possible to fit the nut to a desired and predetermined degree of tightness. Many such additional pieces of equipment will be necessary in the future. Here mechanical engineers can make great contributions to the safety of those handling radioactive materials by developing such equipment.

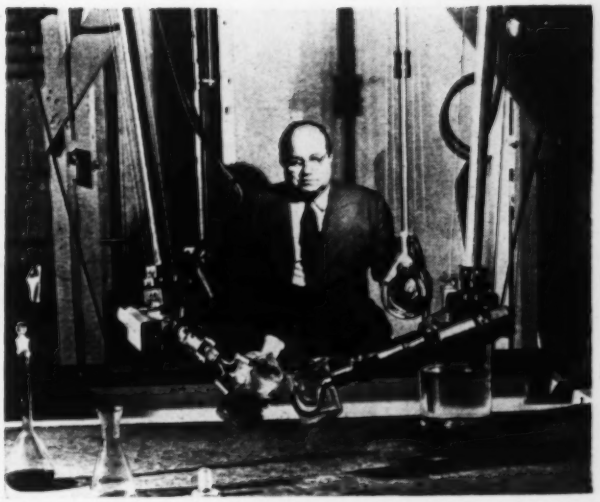

FIG. 11 REMOTE-CONTROL APPARATUS DEVELOPED BY GENERAL ELECTRIC COMPANY FOR USE WITH EXTREMELY HIGH LEVELS OF ACTIVITY

(In actual practice, operations are conducted behind massive shields of lead or concrete, and operations are viewed by a periscope or other arrangements of mirrors.)

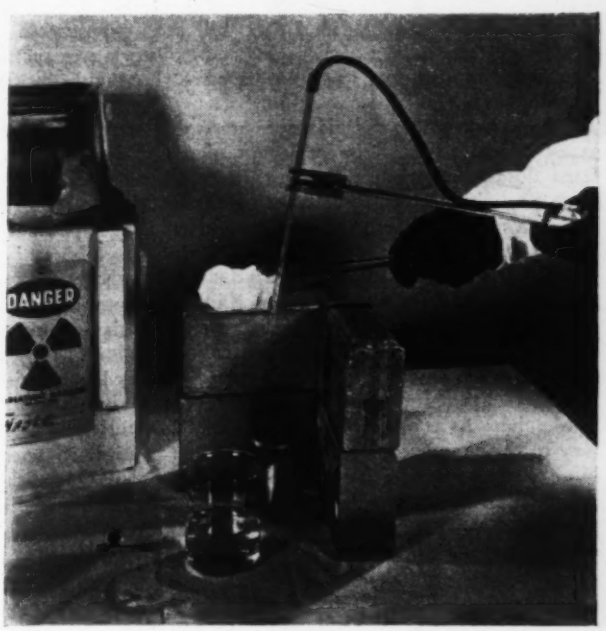

FIG. 12 REMOTE-CONTROLLED PIPETTE USED FOR PIPETTING SOLUTIONS BEHIND LEAD BARRIERS

(Syringe in left hand of operator is used for controlling filling and emptying of pipette.)

For the work of the average laboratory and plant, however, most of the remote-handling equipment is adapted from regular chemical apparatus. Radioactive solutions of gamma emitters are usually handled behind lead bricks, and a typical operation such as removal of a definite volume of solution from a stock bottle, dilution to a known volume, and the like, is performed with a remote-control pipette such as shown in Fig. 12.

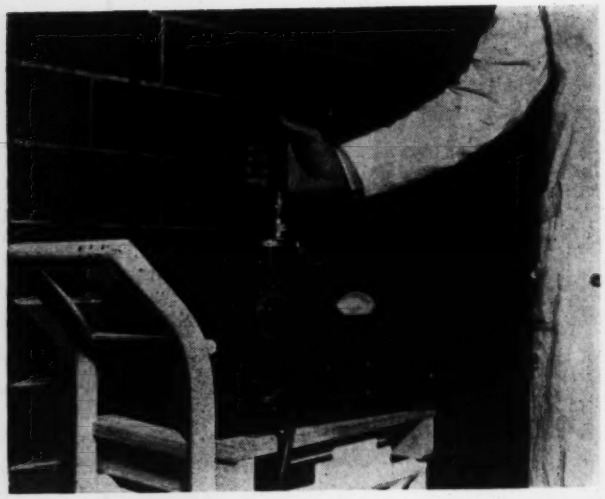

FIG. 13 G-M COUNTER-AND-SCALER ASSEMBLY FOR CHECKING CONTAMINATION OF HANDS

(Maximum permissible level on hands is 700 counts per min as measured with this assembly.)

Surveying and Detection of Contamination. Safe working conditions can be assured by conducting surveys with the proper instruments to supply information from which available working time, shielding, working distance, and adaptation of techniques necessary can be found that will keep exposure to a minimum. The subject of surveying and monitoring of radiation from radioisotopes has been discussed thoroughly by G. W. Morgan (14).

All areas in which radioisotopes are stored or used are surveyed periodically. Reliance is not placed solely on calculated dosage rates but rather on direct measurements made with a reliable instrument. Most operations of simple nature require a survey only at the beginning and end of the operation. At the end of the workday or before leaving the laboratory, each individual working with active materials makes a careful check of his person to determine if he has become contaminated with active materials either on his body or his clothing.

One method of detecting personal contamination is shown in Fig. 13. Located in the hall between various laboratories and the "change room" is a count rate meter equipped with a G-M tube. As people leave the various laboratories on their way to the change room, a quick check can be made to determine whether any activity is present on the hands. One of the suggested maximum permissible levels on the hands is 700 c per m.

Protective clothing is checked at the close of the work day, and a G-M tube attached to a scaler can be used for this operation. If clothing exceeds 300 counts per minute, which is the maximum sometimes advocated, the apparel should be laundered.

Even with the best of intentions, the working areas of a laboratory in which radioisotopes are used sometimes become contaminated. To detect this contamination, an instrument employing a G-M tube, or an ionization-chamber instrument can be used (although, in general, the response from ionization chambers is not as rapid as from the G-M tube, and the sensitivity is somewhat lower). A surface survey is usually performed by moving the detecting instrument slowly over the area suspected of being contaminated as shown in Fig. 14. When contamination is found, the area is clearly delineated with some marking system and cleaned as soon as

(*Continued on page 1030*)

FIG. 14 BENCH TOPS ARE SURVEYED BY MEANS OF A SENSITIVE G-M COUNTER, AND SMALL AREAS OF CONTAMINATION ARE DETECTED READILY

FIG. 15 INGENIOUS METHOD OF CHECKING CONTAMINATION ON LABORATORY FLOORS, USING AN IONIZATION-TYPE METER SUCH AS ZEUS METER SHOWN IN FIG. 2

ATOMIC POWER *and* FUEL SUPPLY

By WARD F. DAVIDSON

RESEARCH ENGINEER, CONSOLIDATED EDISON COMPANY OF NEW YORK, INC. FELLOW ASME

INTRODUCTION

SO MUCH is known about the resources of coal, petroleum, and natural gas in this country that, by comparison, any discussion of the possibilities of utilizing atomic or nuclear fuels is scarcely more than daydreaming. However, the subject is one that deserves attention, if for no other reason than that if even a small part of the wonders that have been forecast for atomic power are realized, the effects on the use of such energy sources as coal may be considerable.

The present purpose is to explore, in a somewhat general way, the problems which must be solved before atomic power can become a reality. There are two aspects to be considered: (1) technical—for until a practical power plant has been built, the rest has no reality; (2) economic—for large-scale use is hardly conceivable unless atomic power plants can produce power at costs competitive with other means.

SOME BASIC FACTS

No method is known, and none has been suggested by competent scientists, for the direct production of electric power from the energy released by nuclear fission. On the other hand, large amounts of heat—equivalent to many thousands of kilowatts—are now being carried off as waste from nuclear reactors used for the production of material for bombs. In one sense the technical problem is that of modifying the reactor so that the heat from it can be used in a turbine to drive an electric generator. This, however, is a great oversimplification. To achieve some understanding of its real character it will be necessary to review certain fundamental considerations.

That certain changes within the nucleus or core of an atom could result in the release of amounts of energy large in comparison with those associated with chemical reactions such as combustion had been known since the discoveries of radioactivity and radium. However, these reactions gave little hope of providing useful sources of power both because the rate of reaction was comparatively slow, and because the rate could not be controlled. In 1939 experiments showed conclusively that some atomic nuclei can split into two fragments of comparable mass with an accompanying release of a large amount of energy which appeared chiefly as heat. In engineering terms, the release was about 4×10^{10} (forty thousand million) Btu per pound, or about three million times as much as from a pound of coal. This gave a new approach. Then, a few years later in a wartime laboratory, it was demonstrated that this "fission" process could be made a self-sustaining or a chain reaction. Until this very important step had been taken the situation had been comparable to that of keeping a fire going with matches, with a gross input of energy greater than the useful output. With a chain reaction, a net useful output became a possibility. That this discovery had not been made earlier is further testimony to the fact that the fission chain reaction can take place only with a very few materials under very special conditions.

The rearrangement of atoms which takes place in a chemical reaction does not change the identity of the atoms. An atom of carbon, for example, remains an atom of carbon whether it is free or combined with hydrogen or oxygen or some other element. The forces that hold the atoms of a chemical substance together are represented as resulting almost entirely from interactions between electrons which move about a central nucleus or sun in much the same way as the planets of the solar system Most of the mass of the atom is concentrated in this nucleus, with considerably less than 1/1000th part in the electrons.

In fission, on the other hand, the nucleus of the atom splits into two parts forming nuclei for two new atoms. If the original atom is U-235—that is, the isotope, or species, of uranium atom with a mass of 235 units—the fragments might be krypton and barium, or some other pair with about the same total atomic weight. This is a fundamental difference from a chemical reaction, and the one which explains the proportionally greater amount of energy that is released.

Greater importance, for the immediate discussion, attaches to another difference. Fission is initiated by a neutron—an electrically uncharged or neutral particle—entering the nucleus of a uranium atom. The neutron is the match or detonator that sets off the fission. On fission the two parts of the original nucleus fly apart with tremendous velocities, and from one to three neutrons are ejected. It is these neutrons with which we are most concerned, for if conditions are right they may enter another uranium nucleus and so set off a new fission reaction. If, on the average, exactly one neutron from each fission causes a new fission, the rate will remain constant; if the average is larger or smaller than one, the rate will increase or decrease with corresponding rapidity. At one limit the action becomes explosive, and the rate of energy release is so great that the temperature may be expressed in millions of degrees and the time in microseconds (millionths of a second); at the other limit the reaction ceases quite abruptly. The chief engineering interest lies of course in the midrange or near the stable or constant-rate condition. Reduction in the rate may always be achieved by inserting into the zone where the reaction takes place some nonfissionable material which will absorb neutrons and thus reduce the number which remain to produce further fission; increase in the rate of reaction may be harder to achieve.

FUNDAMENTAL DESIGN PROBLEMS

Some of the most difficult problems of nuclear-reactor design arise in the imperative need to conserve neutrons so that an adequate supply will be available to maintain the chain reaction, with a small excess to permit control. There are several ways in which neutrons can be lost:

1 By escape from the reactor, for even the best neutron reflectors are only moderately effective.
2 By absorption by "impurities" in the materials of the reactor.
3 By absorption by U-238 without causing transmutation into neptunium.
4 By absorption by fission products.
5 By absorption by structural materials and heat-transfer fluids within the reactor.

Loss of neutrons by escape is less, percentagewise, for large reactors than for small ones, and is less for spherical reactors than for square or elongated ones. Also, it is less for compact or

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high-density reactors than for low-density reactors where a smaller proportion of the space is filled with fissionable material.

Absorption of neutrons by impurities in the materials of the reactor may be large and sometimes necessitates taking very special precautions in the selection of materials.

Absorption of neutrons by U-238 is partially compensated for in some reactors by the transmutation which leads to the formation of Pu-239. This will be discussed later.

To limit the absorption of neutrons by fission products, it is necessary to remove the fission products from time to time. As these will exist as an intimate mixture with the uranium, their removal requires taking the whole mixture—uranium and all—out of the reactor and subjecting it to complex chemical treatments to separate the waste from the unspent uranium which, for large-scale power, will be too valuable to throw away. Since the whole mixture is very radioactive, the processing plant must be designed for almost wholly automatic operation and to permit remote control of those operations which are not automatic. The chemical plant may be remote from the reactor, but the design of the reactor must provide suitable means for changing the charge of the active materials.

The need to limit neutron losses through absorption by the structural materials and the heat-transfer fluids places two heavy restrictions on the designer. For one, almost none of the common engineering materials is acceptable because of the high specific absorption or large "capture cross section," and alternatives must be sought. For the other, the quantities of materials must be limited severely, and this means using them at high stress.

THE PROBLEM OF MATERIALS

The search for materials which meet these requirements is, in itself, a task of major magnitude. Even when the physicist has furnished data on the capture cross sections of particular elements, only a start has been made. Few materials are suitable, in their pure state, for engineering application; most useful materials are alloys, just as steel is an alloy of iron and carbon with a number of other elements. Equally, small amounts of impurity may make the material useless for engineering purposes and, as we shall see, impurities may sometimes be formed within an alloy as a result of exposure to radiation. The investigation of these factors is both costly and time-consuming. After the metallurgical laboratories have developed some alloys which satisfy the first set of requirements, it becomes necessary to investigate suitable methods for production and fabrication on an engineering scale. Aluminum was hardly more than a laboratory curiosity until the Hall process was invented, and commercial production became possible.

After a new material has been produced in trial processes the engineer must examine it to determine how it can be used. Just as a part to be made of cast iron must be shaped differently from one to be made from a chrome-nickel alloy steel forging, so one to be made from one of the new alloys—as yet unformulated—will require its particular shape and proportions, especially if the amount of material is to be kept at a minimum. Then the design and material, and the fabrication processes, must be verified to insure adequate resistance to corrosion and to fatigue, for an unusually high degree of reliability is essential in reactor components.

This brings up another group of problems. It is known in a general way that every material undergoes some change in its physical properties when subjected to neutron bombardment and radiation of the intensities existing in a nuclear reactor. However, only very limited data have been obtained, because adequate facilities for making the studies have not been in existence. Moreover the subject is a very complex one because in this case, again, it is not enough to study the behavior of pure metals; the alloys themselves must be studied. It was noted before that most engineering materials are alloys, and it is emphasized that the valuable properties of alloys often depend on the amount and disposition of one of the minor alloying elements. For instance, the total of all the alloying elements in high-strength aluminum rarely exceeds 6 or 7 per cent, and yet the ultimate tensile strength of the alloy may be 2 or more times that of commercially pure aluminum. The tensile strength and resistance to fatigue and corrosion of such an alloy might be impaired seriously by the alteration in the silicon content due to radiation, even though 90 per cent or more of the aluminum remained unaffected.

The problems to be assigned to the metallurgists are, therefore, both numerous and formidable. Before we leave the subject of materials and turn to problems more in the field of engineering, we should not overlook the possibilities of help from the ceramics experts. Ceramics and glass, although among the oldest materials made by man, have been little used for engineering purposes until recently, and even now their potential uses are only partially understood. However, ceramics cannot be looked on as direct substitutes for metals. To realize their full potentialities, the engineer must be ready to make quite radical changes in his design.

NUCLEAR FUELS

Before proceeding to a consideration of some of the specific engineering problems of reactor design, we must divert to a short discussion of fissionable materials and nuclear fuels.

The technical problems of both the designer and the operator of fuel-burning boilers would be made much simpler if basic fuels such as coal were first converted into gas in a separate plant, about which the power man had no concern or worry. Of course in a practical way, such a solution of troublesome problems is never possible, for the question of costs—the total costs—cannot be ignored. In much the same way power-reactor design could be made far easier if the designer could contemplate the use of concentrated uranium-235 or plutonium-239 rather than natural uranium, which contains only 0.7 per cent of fissionable U-235 and about 99.3 per cent of nonfissionable U-238. Such a solution again evades the question of cost, and it also evades in some degree the question of adequate supply.

The early designs for atomic bombs contemplated the concentration of the U-235 in natural uranium, and several elaborate and costly "isotope separation" plants were built, mostly at Oak Ridge, for accomplishing this.

Experience with these processes has shown that the power requirements are so large that the amount of energy used in them is comparable to that available for power purposes in the finished product. Large-scale power production—which is our main interest here—if based on such methods would merely introduce a new step in the cycle and not result in any reduction in the use of coal, oil, natural gas, or water power. Clearly, such arguments as this are of minor importance for a limited number of special power applications, such as for the propulsion of naval vessels, and they are without force when considering bomb materials.

It is fortunate that the possibilities do not end here, and that nuclear reactions are known which give promise of making it possible to utilize the U-238 as well as the U-235. These reactions, as used in the processes for the production of bomb material, involve several steps. In the first step, a neutron released by the fission of an atom of U-235, after being slowed down by successive collisions with nuclear particles such as the nuclei of carbon atoms, enters an atom of U-238, which then becomes an atom of U-239. In the next step the U-239 emits a beta particle, or electron, to become an atom of neptunium-239, and then, by another like radioactive transformation, the Np-

239 transmutes into plutonium-239. This end product is fissionable in the same way as U-235, and it can be used to "recycle" the process. Moreover, since more than one neutron, on the average, is released on the fission of each atom of U-235, the possibility exists, if the loss of the neutrons can be made small enough, that the number of new atoms of Pu-239 will be greater than the number of atoms of U-235 destroyed by fission, and that there may be an actual increase in the quantity of fissionable material, with the nonfissionable U-238 providing the substance or mass. There is also an analogous series of nuclear reactions by which fissionable U-233 can be produced from nonfissionable thorium-232. These "breeder" reactions offer the hope of being able to increase the potential supplies of nuclear fuels by a factor of 140 or even more.

However, as so often happens, this gain is not without its price. To get the maximum breeding of new fissionable materials, neutron losses must be kept to the very minimum, and this is incompatible with meeting the design requirements for a power reactor, particularly as to those for heat transfer and for control.

GENERAL REACTOR DESIGN

With a tentative list at hand of materials which do not have large neutron capture cross sections and which show adequate stability when exposed to radiation, and with some decision as to the kind of nuclear fuel to be used, the engineer may make a start by outlining a preliminary design.

Extreme compactness is essential to insure needed conservation of neutrons, and this means high rates of heat transfer and high mechanical stresses, both of which are incompatible with a high degree of reliability. Because of the extreme difficulty, which may amount in some cases to the absolute impossibility, of making repairs to a reactor after it has been put in operation and has become radioactive, every practical means must be taken to insure against failure of any parts. But as perfection in this is unattainable, the design must make provision for some maintenance and repair work.

At this point we will return, for purposes of illustration, to the Hanford type of reactor, keeping in mind all the while that the final design may be for a quite different reactor.

In the Hanford reactors, uranium bars, sealed in closely fitting aluminum tubes, are inserted into other tubes which line holes running through blocks of graphite "moderator." Water is circulated through the annular space around the "slugs" and inside the tubes to carry off the heat. Although the total heat is equivalent to many thousands of kilowatts it is not usable in a turbine because the temperature is too low.

A basic concept of great importance in designing heat engines—and steam or gas turbines are heat engines—is known as Carnot's principle. This states that the maximum efficiency at which any simple heat engine can transform heat into mechanical power is dependent on the range of temperature of the working fluid (steam or gas) according to the formula

$$\eta = 1 - (T_2/T_1)$$

where T_1 is the initial (or higher) temperature and T_2 is the final (or lower) temperature. For this use the temperatures must be expressed on the absolute scale for which the numbers are 460 greater than for the Fahrenheit scale.

To see more clearly what this means, we may assume quite favorable conditions, as with cooling water from a river or lake available for condensers at 75 F (535 R). With steam at 350 F (corresponding to a pressure of 120 psig) the maximum attainable efficiency would be 25 per cent, and the actual efficiency considerably below this figure because of unavoidable mechanical and heat losses. With air cooling, as would be used with many gas turbines, the final temperature might be above 300 F, and to attain an actual (rather than theoretical) efficiency of 25 per cent the initial temperature would have to be above 1000 F.

One way to get higher temperatures from the Hanford reactors would be to reduce the flow of water until there was steam generation. This, however, is open to a number of very serious objections, prominent among which is the fact that the steam, because its density is lower than that of water, will have a lower specific absorption for neutrons and this difference may be great enough to cause very serious disturbances in the operation of the reactor. Increasing the pressure so as to permit reaching higher temperatures without steam formation is not an immediately acceptable alternative because this would necessitate thicker walls for the tubing and a greater weight of inactive metal in the reactor.

HEAT TRANSFER A PROBLEM

An evaluation of possible heat-transfer fluids presents complex and difficult problems because of the many factors that are involved. Gilliland[1] has made an interesting start. Taking into account various physical properties such as specific heat, thermal conductivity, density, viscosity, which influence heat transfer and the power necessary to circulate the fluid, he has developed two sets of parameters which give measures of the relative merits of different fluids. He then calculated the values of these parameters for 21 gases and vapors and for 15 liquids and molten metals. A study of these values and of data on neutron capture cross section led him to select four media for further study. They are helium, water (in spite of the objections noted), molten cadmium, and molten lead. Other investigators have added air and some eutectic mixtures involving lead.

The inclusion of molten metals in the list may seem strange because it is obvious that they cannot be used directly in a turbine or heat engine. The justification comes from the fact that a "two-stage" heat-transfer system probably will be necessary in any case. With this system one fluid, which does not vaporize, circulates through the reactor where it picks up heat and then through a steam generator or heat exchanger where it gives up that heat to make steam which will be used in a steam turbine or to heat gas which will be used in a gas turbine. This arrangement has the great and overriding advantage of providing isolation of the turbine and its auxiliaries from the radioactivity which the fluid circulating through the reactor will acquire. Without it, turbine parts would soon become radioactive or so contaminated by radioactive materials that usual procedures for making operating adjustments and repairs would have to be replaced by others using remote-control robot devices. It does not, however, wholly avoid problems of this kind for there must be pumps or blowers for circulating the fluid in the first circuit and these must tolerate the radioactivity.

Before a final selection of the heat-transfer fluid can be made it will be necessary to re-examine the question of structural materials and particularly those used in the active zone of the reactor. In addition to the requirements previously noted, the materials must meet some others. They must not be corroded or attacked severely by the heat-transfer fluid; they must have low specific neutron absorption; they must have adequate strength, especially at high temperatures; they must have adequate thermal conductivity; they must be capable of fabrication; they must have good stability when exposed to radiation. No common engineering material begins to meet all these requirements, which are sometimes conflicting, and progress in the development of power reactors is dependent in a large de-

[1] "The Science and Engineering of Nuclear Power," chapter on "Heat Transmission," Addison-Wesley Press, Cambridge, Mass., vol. 1, 1947.

gree on the success of the metallurgists in meeting the challenge thus put to them.

MEANS FOR REPLENISHING THE CHARGE

Another detail of reactor design which requires careful study is the means for removing the partially spent charge and replacing it with new active materials. The fission products are generally active neutron absorbers so it is important that they not be allowed to accumulate unduly. Also depletion of the charge reduces the level of activity so that the chain reaction will cease before all the charge has been used up. In the Hanford reactors, bars or slugs of uranium, in their aluminum cases, are removed from time to time and replaced by fresh ones. Such a process seems, however, to be ill-adapted to a power reactor, and a continuous process of some kind would offer many advantages if it could be devised. Such a process might be deemed as analogous to the continuous feed of coal in a stoker or in a pulverized-coal burner which has replaced intermittent hand firing in modern coal-burning power plants. The partially spent charge would be sent to a chemical processing and reclaiming plant, as was noted before.

CONTROL

Basically, control of the reactor is accomplished by moving rods of neutron-absorbing material into or out of the active zone. Cadmium has been used generally because it is a particularly effective absorber of neutrons, and therefore the control rods can be small. Actually, the control presents many very difficult problems. The control of the neutrons so as to control the fission rate cannot be concentrated at one convenient point, but must be distributed throughout the reactor if local zones of excessive temperature are to be avoided. The control system also must be responsive to changes in neutron flux density which take place rapidly, and not depend wholly on temperature of the heat-transfer fluid, or on changes in steam pressure which take place much more slowly. Additionally, the control system must include a large number of instruments and detectors to give warning of failures of one kind or another, such as the development of leaks of heat-transfer fluid, or the escape of radioactive gas.

Therefore the control and protective systems will require a large array of instruments and servomechanisms. Some will be of rather conventional type, possibly modified to give better life when exposed to radiation, but a large part will require new developments. That the problems can be solved is demonstrated by the successful operation of a number of large reactors used for the production of bomb materials, yet the opinion has been expressed in a recent paper[2] that finding a satisfactory solution may be crucial to the future of nuclear power.

SHIELDING

The need for heavy shielding to protect personnel and equipment from injury or damage due to radiation has been mentioned in nearly every discussion of atomic energy. Gamma rays, which are similar to x rays, and neutrons are the most difficult to deal with for they are not stopped completely by any thickness of shield, and the design must be based on a tolerable residual intensity. In designing the shielding for a reactor, a large amount of ingenuity is necessary to devise means for insuring the effectiveness of the shield and, at the same time, providing means for making connections, installing instruments, and so forth. Provision must also be made for essential maintenance operations.

The shielding problem, however, extends beyond the reactor. The heat-transfer fluid will become radioactive and, in turn, may induce radioactivity of somewhat less penetrating types in materials with which it comes in contact. Thus the first heat-transfer circuit and all the equipment associated with it will require some shielding, again with provision for access for making maintenance repairs.

So long as the heat exchanger or steam generator does not develop any leaks, the tube walls will form an adequate barrier to isolate the steam or gas system, but it will be unsafe not to make some provision for dealing with the situation if a leak should occur.

STEAM GENERATOR AND SOME AUXILIARIES

The steam generator itself presents some new problems. For one, the need for keeping to a minimum the volume of fluid in the first heat-transfer circuit points to the desirability of using high rates of heat transfer, and this, in turn, means that particular care must be taken to insure continued cleanliness of the surface and freedom from sludge and scale deposits. For another, it means that there must be carefully planned arrangements for treating the feedwater and conditioning the boiler water. It means, too, provision of adequate facilities for inspection and periodic cleaning.

If molten metal is used as the heat-transfer fluid, provision must be made for draining the system on shutdown or for melting the metal in place when starting up. If air is used, attention must be given to the safe discharge back into the atmosphere, for there will be a moderate amount of radioactivity. Extensive studies dealing with this last problem are now under way at the Brookhaven National Laboratories.[3]

We now turn our attention to the power plant. What will it look like? There are no compelling reasons why the turbogenerators and the switchgear should differ greatly from those of fuel-burning power stations. Possibly they will be a little larger because of the advantages of large reactors, but that is about all. The real differences will be in the steam-generating equipment and the facilities for fuel-handling.

Instead of large steam generators, often of impressive height, there will be a much smaller cubic reactor encased in a massive concrete and metal shield and another unit, the steam generator, in a less massive shield. There will be circulating pumps to handle the molten metal heat-transfer fluid or blowers if air is used. In either case these will be large units, for present studies all indicate that the power requirements will be large because of the high velocity at which the fluids must be circulated through constricted passages. Boiler feed pumps will be conventional.

There will be no coal-handling equipment, no coal pulverizer, no air preheaters; there will be no dust collectors; there will be no ash-sluicing or slag-tap system. Instead there will be massive containers, probably lead-lined, for handling the partially spent charge and removing it to the chemical plant; there will be less massive containers for handling the replenishing charge.

The control room will be more elaborate than in the fuel-burning counterpart, and will have more interlocks and automatic features.

COSTS

What will this power plant cost? A large high-efficiency coal-burning power plant today will cost something like $190 per kw. Of this, about one half or, say, $100 per kw would be needed for the part that would be duplicated in a nuclear power plant. There is not an adequate basis for a sound estimate of the other costs, but it may not be unreasonable to assume that

[2] "Some Instrumentation Requirements in an Atomic Power Plant," by D. Cochran and C. A. Hansen, Jr., MECHANICAL ENGINEERING, vol. 71, October, 1949, pp. 808–810 and 820.

[3] "Stack Meteorology and Atmospheric Disposal of Radioactive Waste," by N. R. Beers, *Nucleonics*, vol. 4, April, 1949, pp. 28–38.

they will be at least 3 times those of the coal-burning station. This gives a figure of $370 per kw for the complete nuclear power station.

How will operating costs compare? The largest item for coal-burning stations is fuel. For the nuclear station the costs could conceivably be far lower, if—and this is an important "if"—ample supplies of uranium ores are found and if it is found possible to reduce greatly present costs of reclaiming and reprocessing the partially spent uranium. (At some later date, thorium may enter the situation as an alternative to uranium.) About the best that one can do now is to say that under present conditions uranium as a fuel for power plants is much more costly than coal, but at some later date it may become somewhat less expensive. As to other operating costs, it seems clear that until there has been extensive experience with nuclear power plants, labor supervision, maintenance, and repair are all likely to be higher than for coal or oil-burning stations.

SOME FACTORS INFLUENCING COSTS

It must be kept in mind in any attempt to draw conclusions from these figures—and they are at best only the roughest sort of guess—that they have been set up on the assumption that the power plant was single-purpose development. If, as seems not unlikely, power plants are built as part of a multipurpose development, then the allocation of common costs, which is to some extent quite arbitrary, may alter the picture.

There are, however, some additional considerations. In making a comparison of nuclear and fuel-burning power plants, it should not be assumed that they can be placed on sites equally advantageous with relation to the load. Until years of successful operation have proved their reliability, no prudent engineer would place a large nuclear power station in the heart of a large city or in densely populated or industrially very important areas. The ever-present chance, however small, that something might go wrong and release large amounts of intensely radioactive material would dictate sites in areas where a failure would be less disastrous. This may necessitate added transmission, the costs of which must be considered.

The large size of nuclear power plants may operate to their disadvantage in regions of low load density, for no single small area such as a city may have enough load to justify such a station, and adequate load could be found only by supplying other areas through a transmission system, the costs of which must be taken into account.

The disposal of radioactive wastes presents many problems for which solutions may be found only by distance from centers of population. This does not mean that the power plants must be located in remote regions, for there is the possibility of shipment in suitably shielded cars or ships, but the costs of such operation cannot be ignored.

Almost regardless of what costs may be for nuclear fuels, the energy per unit weight is so great—about 3,000,000 times that of coal—that shipping costs of the uranium will be practically negligible as compared with those for coal or petroleum or transmission costs for natural gas. (This does not apply to the partially spent charge which must be handled in very heavy shields.) Therefore, in the absence of tariff barriers and artificial price control, the fuel cost will be the same at any place in the world. Aircraft and surface vessels might, in theory, be made free from the high price they must now pay for carrying their fuel with them.

This advantage must not be confused with one that has sometimes been claimed for nuclear power plants. It has been suggested that they offer particular advantages in areas where adequate supplies of condenser cooling water are not available in lakes or rivers, but this does not meet the test of critical analysis. A heat engine (steam turbine or gas turbine) is required in either a nuclear or a fuel-burning plant and the conversion efficiency will be influenced equally by the availability or lack of cooling water. Higher final temperatures mean lower efficiency, larger turbines, larger steam generators, larger reactors, and so forth, and they mean higher fuel consumption. All that can be said with certainty is that at some time in the future nuclear power plants may not be influenced as adversely as fuel-burning power plants by lack of natural cooling-water supplies.

SUMMARY

There appear to be no unsurmountable technical barriers to the development of large nuclear power plants, but it is by no means clear that such plants can offer anything like as great economic advantages as have often been predicted. In fact, the outlook as to costs, even if the enormous development costs were to be charged entirely to other projects, is such that one would not expect rapid large-scale inroads of nuclear power into the field of industrial power production. At most, nuclear power plants might represent most of the new capacity and thus be a supplement to rather than substitute for power from coal, oil, gas, and water power.

Radiation Detector

PRODUCTION has started on a new type of radiation detecting and measuring device suitable for use by both military and civil defense organizations, the Department of the Army announced.

As the first instrument of its type designed specifically for rugged field use, the device is considered a significant contribution to radiological defense. It employs what physicists call an "ionization chamber," not new in itself but new in this form. Specifications for the device were drawn by the Army Signal Corps.

Intentionally made less sensitive than the Geiger counter, the new instrument is designed to detect and measure relatively large concentrations of radiation, such as would result from an atomic-bomb blast. The Armed Services call it a "radiac set," radiac being a coined word standing for "radioactivity detection, identification, and computation."

The new radiac set is designed primarily for use in training troops as radiation survey teams. Such teams would, in event of an atom blast, go over the affected area to determine when and where it would be safe for human beings to venture, and for how long they could safely remain.

The instrument has been designed with an eye to possible combat use. It contains standardized components, will stand up under shock and vibration, and can be repaired easily in the field. It is a small instrument $10^1/_2$ in. long in its greatest dimension, and weighs 10 lb.

Within the steel case of the new radiac set is a gas-filled chamber (the ionization chamber) which contains two electrodes. The electrodes carry positive and negative electrical potentials, respectively. When the instrument is carried into a "hot" area, gamma rays pierce the gas chamber's wall and dislodge electrons from gas atoms. The electrons, negatively charged, are attracted to the positive electrode in the ionization chamber. The atoms from which the electrons have been dislodged now are positive ions and are attracted to the negative electrode. A very weak current flows, is amplified by the electronic system in the radiac set, and is read off a meter.

The instrument would be used in regions of radiation intensity beyond the capabilities of the Geiger counter.

DESIGN CONSIDERATIONS *for* MANUFACTURING ECONOMY[1]

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INTRODUCTION

BEFORE the designer there lie two broad fields which might be termed generally, "functional design" and "production design." Functional design may be looked upon as the conception and development of an idea into a product, mechanism, or machine which will perform a specific function. Normally the primary aim is to achieve a design which will accomplish the desired purpose, will function satisfactorily and will meet the necessary practical performance requirements. Production design, on the other hand, directly follows functional design and comprises basically the study and redesign of the functional parts to simplify manufacture—in one sense a process of fitting the parts for the simplest mostrapid method of manufacture.

Careful designing for production can achieve a variety of substantial economies in manufacture, a factor all too often overlooked. The tendency to ignore or to forget the broad limitations inherently present in all processing methods is ever-present. The number of products and machine parts which, as originally designed, are impossible or excessively costly to process is amazing. The point has been made many times but it should always be remembered that a mechanism which is impractical to manufacture is just as much an indication of poor design as a mechanism which will not function or perform properly.

ECONOMICAL MANUFACTURING

Economical and thoroughly practical production design of machine parts must be based to a great extent upon a wide knowledge of the various basic methods employed in manufacture. By concentrating on basic operations available through the readily tooled and adapted production methods rather than solely on the product or part to be made, maximum economy, flexibility, accuracy, and speed in manufacture can be realized. Although this may seem a long step in a new direction in some respects, for the most part, it is actually only the elimination of the long and arduous path by which altogether too many parts must be redesigned or, rather, changed to bring them back into the scope of economy through a roundabout means from the shop, production planning,or tool-design department primarily because the designer ignored or was unaware of the limitations present in the method of processing necessary. Again, it is often found that a part can be more readily or more economically produced to the desired basic specifications by a method not considered or inadvertently overlooked; and this with but a few simple design changes. Achieving minimum cost of production for a specific design and also maximum value from the least amount of material, requires high output per hour, low tooling costs, minimum setup time, and the like. It also means simplicity of physical design features, and proper evaluation and consideration of all possible methods by which the part can be made.

It is readily recognized that, under any circumstances, some designs will necessarily require development of new processing methods, and eventually methods will be available by which practically any type or product can be produced economically, whatever the desired quantity. Development of a radically new method of processing, however, should be demanded only when a thorough analysis has exhausted the possibilities of present methods. The idea, though, is not to dispense summarily with the special-purpose production machines, but to seek the specialized method only where no other method will provide the necessary results.

DESIGN LOGIC

All too often, design of a particular component is carried out arbitrarily without first raising these two important questions:

1 Will the material specified and the physical design features adopted lend themselves to processing at minimum cost as well as adequate production speed?

2 Will the most economical production method available maintain, at the desired or necessary output speed, the required dimensional tolerances?

Arrival at the most satisfactory answer to these questions more often than not becomes to a certain extent a matter of compromise. For instance, in a great majority of cases, close tolerances decrease severely the maximum possible production speed—as well as increase the scrap output—and, as a consequence, increase the cost per piece. Each production method, it must be remembered, has a well-established level of precision which can be maintained in continuous mass production without exceeding the normal basic costs. No amount of inspection actually will improve this level, and for practical low-cost production it must be observed.

It also must be recognized that each method has a minimum production-quantity level, below which the cost per part would be excessive, Fig. 1, although this value may vary widely depending upon specific design characteristics. Manufacturing economy may influence the final design to a great extent, both as to physical characteristics and dimensions. And, harking back, it has a direct effect upon the tolerances which must be taken into consideration. A flame-cut component necessarily would carry much broader tolerances than a substitute design which could be press-formed or blanked.

Except in widely scattered cases, the general design characteristics and quantity requirements of specific machine parts usually can be expected to place them in a well-defined production category. Little, if any, actual competition or overlapping of production methods exist. Once a design is conceived and the quantity, environmental conditions, physical characteris-

[1] The material contained in this paper will appear in the author's forthcoming book "Production Processes . . . Their Influence on Design."

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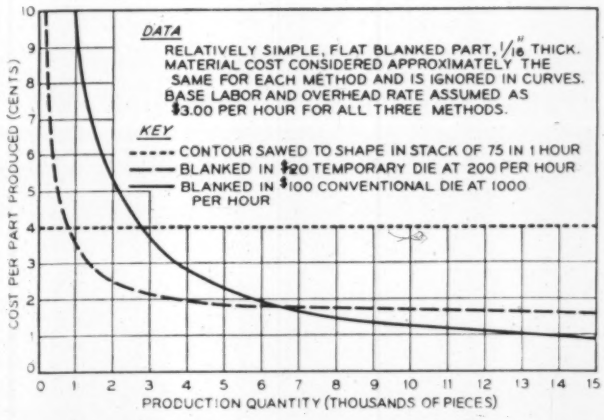
DATA
RELATIVELY SIMPLE, FLAT BLANKED PART, 1/16" THICK. MATERIAL COST CONSIDERED APPROXIMATELY THE SAME FOR EACH METHOD AND IS IGNORED IN CURVES. BASE LABOR AND OVERHEAD RATE ASSUMED AS $3.00 PER HOUR FOR ALL THREE METHODS.
KEY
CONTOUR SAWED TO SHAPE IN STACK OF 75 IN 1 HOUR
BLANKED IN $20 TEMPORARY DIE AT 200 PER HOUR
BLANKED IN $100 CONVENTIONAL DIE AT 1000 PER HOUR
COST PER PART PRODUCED (CENTS)
PRODUCTION QUANTITY (THOUSANDS OF PIECES)

FIG. 1 QUANTITY-COST RELATIONSHIP OF BLANKED PARTS USING TEMPORARY AND PERMANENT-TYPE DIES

Cost of temporary dies, with few exceptions, averages around 20 dollars while that for a permanent die to produce the same part would run about 100 dollars, although the cost ratio may vary from 4-to-1 to 10-to-1, according to complexity of design. Ten thousand parts can often be run on temporary dies before die wear is excessive, and in some cases as many as 15,000 to 20,000 can be produced.)

tics, and the like, are known, almost invariably it will be relegated to a particular method. On occasion, several methods actually can be considered, granting sufficient latitude in certain of the design requirements. Where a part can be redesigned or altered in order to bring it into the realm of a speedier more economical process, retaining only the primary functional characteristics and perhaps sacrificing some relatively unimportant details, tremendous gain in production along with accompanying decrease in cost per piece can be realized, Fig. 2. In addition, the design frequently will be simpler, lighter, and often better mechanically. Such achievements, however, must originate during the design stage, for it is here that manufacturing costs are largely controlled. Design which achieves minimum cost commensurate with satisfactory service is to a great extent the result of thorough "processing" by an alert designer.

Actually, the drawings and specifications of the designer establish minimum manufacturing cost to a far greater degree than is often recognized. Regardless of efficiency, tooling, or purchasing efforts, the designer's influence on manufacturing costs sets the limits beyond which little improvement can be made. Total design effect upon manufacturing costs has been shown to average as much as 35 per cent of the major over-all costs consisting of raw materials, equipment, direct and indirect labor, tooling, and engineering. The hydraulic cylinder shown in Fig. 3, for instance, when redesigned with proper consideration of economical production possibilities, resulted in approximately 85 per cent reduction in cost over the original design in spite of increased labor costs.

Achievements such as the foregoing can be realized where the design engineer is familiar not only with general manufacturing processes but especially has intimate knowledge of the equipment and facilities available in his plant and the general shop practices used. The designer must know from experience the capabilities of the various automatic production machines in order to make optimum use of them. He must know what standard parts can be fitted to his requirements and whether or not certain parts can be obtained from outside sources at lower cost than if produced in his shop. Again, full knowledge of

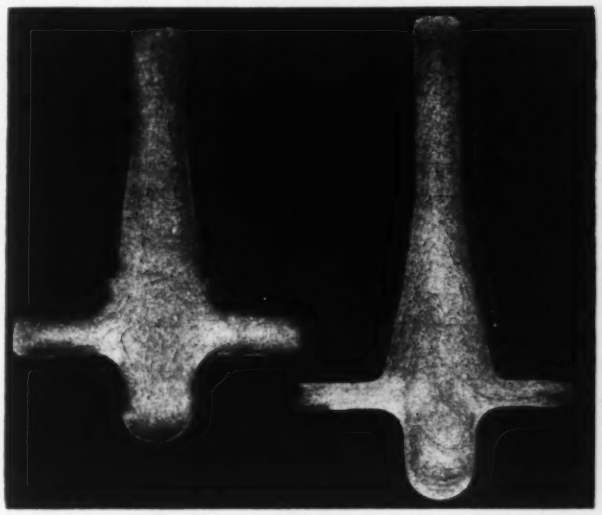

FIG. 2 FRONT-WHEEL SPINDLE FOR A PASSENGER CAR AS HAMMER-FORGED, LEFT, AND AS PRESS-EXTRUDED, RIGHT

(Better orientation of grain flow as well as reduced cost in time, men, machines, and materials were achieved.)

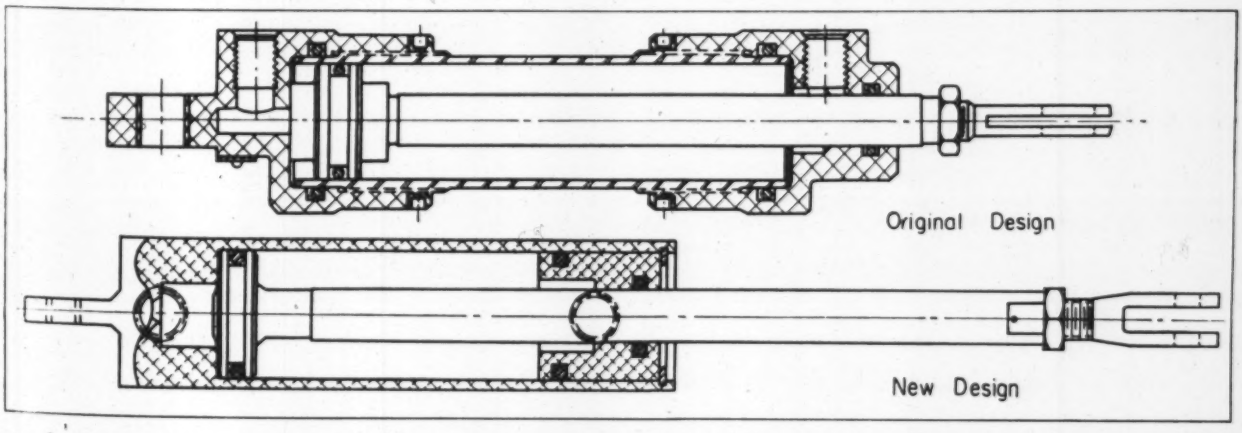

FIG. 3 CONVENTIONAL HYDRAULIC ACTUATING CYLINDER FOR TAIL-WHEEL EXTENSION OR RETRACTION, AND NEW SIMPLIFIED DESIGN WHICH COSTS APPROXIMATELY ONE SIXTH AS MUCH

(By designing each part with attention focused on economical production operations, total number of operations and number of separate parts were reduced, cylinder was 40 per cent lighter, yet provided same operating capacity.)

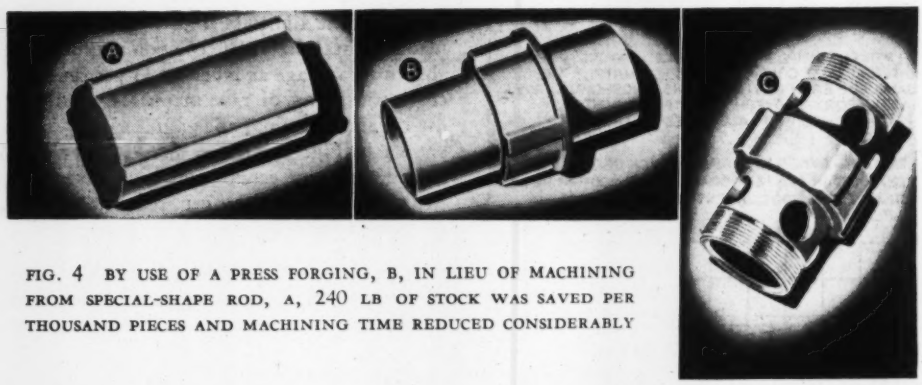

FIG. 4 BY USE OF A PRESS FORGING, B, IN LIEU OF MACHINING FROM SPECIAL-SHAPE ROD, A, 240 LB OF STOCK WAS SAVED PER THOUSAND PIECES AND MACHINING TIME REDUCED CONSIDERABLY

other parts produced in his plant will enable the use of such parts already in production to provide the advantage of savings resulting from manufacture of larger quantities.

GENERAL RULES FOR DESIGN

Sound design which incorporates the advantages of maximum economy in manufacture therefore necessitates consideration, both separately and in combination, of a number of basic rules which can be outlined generally along the lines in the following, although their relative importance need not necessarily be in the order shown.

Design for Maximum Simplicity of all Functional and Physical Characteristics. This is a point that is rather self-evident but because it is continually overlooked, can bear re-emphasis and vigilance on the part of the designer. Production cost has a direct relation to the complexity of a design, and generally service life is extended considerably where parts can be simple and sturdy. It has been emphasized many times that where design configuration of a part can be simple and uncomplicated, the load-carrying capacity of the part is generally more certain. Because the computation of stresses within a complex structure is extremely difficult, and actual stress distribution often obscure, the value of simplicity is at once apparent.

Perhaps the question regarding the parts of a new design should be, "Is it absolutely required?" The most obvious way to cut costs is to eliminate or combine parts to obviate the expense of attaching or assembling. However, the opposite possibility of breaking down a complex part into two simpler parts, more economical to produce and assemble, should not be overlooked either. The highly important requirement of fast satisfactory assembly, especially on the production line, must also be kept in mind. Machines or mechanisms which are difficult to assemble not only incur greatly added production costs but also, in certain cases, may engender considerably increased maintenance difficulty and, as a result, receive poor customer acceptance.

The great importance of simplifying design and assembly has been exemplified extremely well by aircraft developments during recent years. It has been shown[2] that design simplification makes possible unexpected reductions in airplane manufacturing costs; calculated savings of $1,620,000 over a period of one year were made at a cost of only $20,000 in engineering time. Noting the vast difference yet present when considering the low cost per pound of automobiles and refrigerators, another authority has concluded,[3] "refinements of design and analysis are the key to sharp reductions in airplane costs

[2] "Cost Control Spotlights the Design Stage," by John Van Hamersveld, *The Martin Star*, vol. 3, November, 1948, p. 10.

[3] "The Design of Simplified Structure for Low Cost Airplanes," by A. F. Boyajian, *Aeronautical Engineering Review*, vol. 5, July, 1946, pp. 18–24 and 29.

FIG. 5 MONEL VALVE STEM FOR RAILROAD TANK CARS ORIGINALLY MACHINED FROM SAND CASTINGS OR ROD IN LOTS OF 2000 AT A COST OF $18.75 EACH, WAS REDESIGNED FOR INVESTMENT CASTING AND PRODUCED AT A COST OF $9.90

—not revolutionary improvements in production techniques."

Design for Most Economical Production Method or Methods Available and Observe Their Inherent Design Limitations. This means that once a machine or product is conceived, the various methods by which each part can be manufactured should be considered seriously, weighing factors such as quantity to be produced, physical features, accuracy, production speed, scrap, equipment available, and the like, as to their effect on final costs. It is particularly important to keep in mind the scrap problem. Ratio of weight of material required to weight of finished piece provides a clue to possible cost reductions, especially in mass production. The aluminum valve body, Fig. 4, originally produced from special-shape rod, required 460 lb of material per 1000 pieces. However, redesigned for forging, only 220 lb of material was needed per 1000 pieces. Considerable reduction in machining time added to the cost savings.

As indicated previously, the successful performance and relative cost of similar parts depend primarily upon the thoroughness of this "processing" procedure. Often the most satisfactory method from a cost and design basis is not a well-known

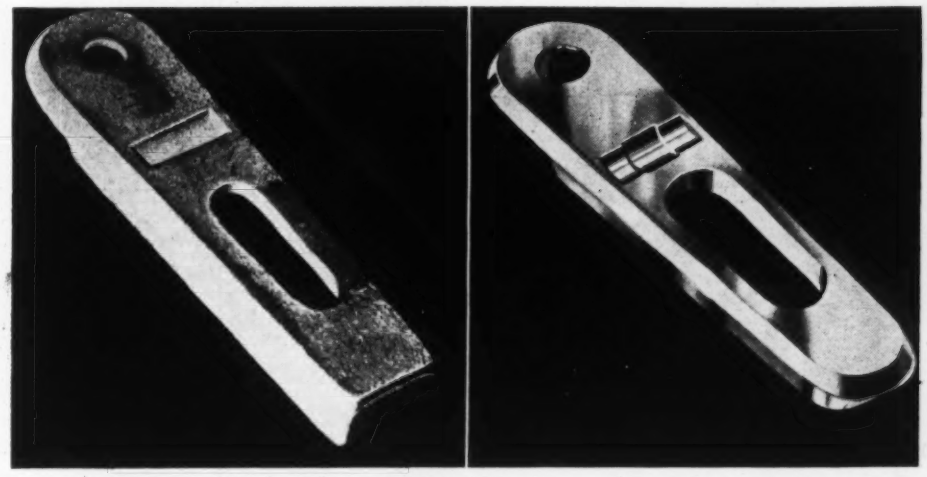

FIG. 6 SAVINGS OF APPROXIMATELY 6 CENTS PER PART IN FINISHING COSTS ALONE WERE EFFECTED ON THIS SURGICAL INSTRUMENT BASE BY USE OF FORGINGS, RIGHT, IN LIEU OF SAND CASTINGS, LEFT
(Better chrome plating for this service also resulted with forged metal.)

FIG. 7 TWELVE-PIECE INVESTMENT CASTING OF JET-ENGINE TURBINE BLADES IN VITALLIUM ALLOY
(Characteristics of this material necessitate use of a process which offers high accuracy without machining. Blades are completed by abrasive cutoff, sandblasting, and light grinding on fitted portions such as blade roots.)

one; rather it may be a somewhat obscure but extremely valuable method such as investment casting, electroforming, or die rolling. The valve stem shown in Fig. 5 was reduced in cost almost 53 per cent by redesigning for investment casting. Again, the best process to use may be one not yet widely available commercially such as cold extrusion, or where idle processing facilities are available the part can be designed expressly to employ such equipment and balance the use of production machinery.

Inherent limitations in each process thus may present a far greater effect on costs than ordinarily realized if a thorough survey is not made. Where pressuretight parts are required, it may be wise to question the use of sand castings; rejections can be costly. The case may be similar where high-quality surface finish or plating is contemplated. Grinding and buffing costs for the part shown in Fig. 6, ran high, and defects uncovered by these operations caused about 10 per cent rejections Use of forging resulted in savings of approximately 6 cents per piece on finishing alone, reduced rejects to zero, and eliminated complaints regarding inability of the plating to withstand repeated sterilization.

Select Material to Suit the Production Method as Well as the Design Requirements. It is always necessary and extremely important that the designer carefully consider the materials to be used. Should a design be most adaptable for production on one of the various automatic lathes, screw machines, or turret lathes, the primary consideration must be a free-machining material. For instance, though aluminum alloys and aluminum-alloy forgings cost somewhat more than steel for parts of similar design, time required for machining aluminum-alloy parts is often sufficiently lower (about one third that required for similar steel parts) to offset by far the original additional material cost. Magnesium alloys provide an even greater advantage, machining time being one sixth that of steel. If low-machinability material must be used, then thought should be given to producing the part by means of another process, where machinability, which is so necessary for turning operations, is not a factor, if high costs are to be avoided on quantity runs.

Where design requirements allow little or no leeway as to material selection, the design will be influenced directly by the production methods by which the material can be worked readily, as in the case of jet-engine turbine buckets, Fig. 7. Because of the high-temperature-resistant materials used these buckets cannot be machined or forged, as they must be produced by a means which requires little or no machining or working. Again, where powder-metal-pressing is considered, the vast difference in the characteristics of the sintered parts must be kept in mind.

Where heat-treatments or hardening are found to be a necessity, careful consideration as to the material selected and its adaptability to processing prior to heat-treating is imperative. With proper selection of heat-treatment procedure, a material which can be machined or formed readily can usually be adopted. In fact, where close accuracy must be maintained and variations from heat-treating distortion obviated, materials which offer good machinability following heat-treatment can be utilized. Just as simple weldments can be used to supplant more costly forgings where quantity is not sufficiently great, so

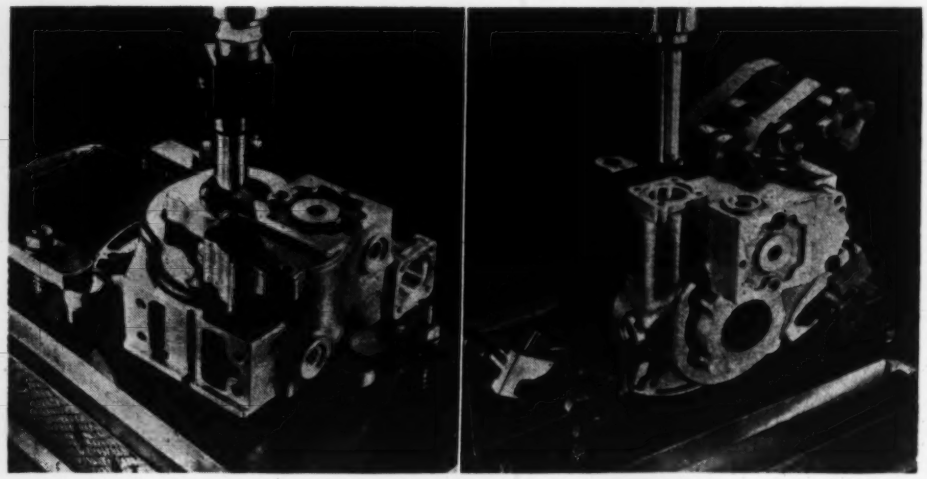

FIG. 8 LUGS CAST ON THIS RADAR DRIVE-GEAR HOUSING ARE USED FOR LOCATING AND CLAMPING DURING VARIOUS MACHINING OPERATIONS

(Lugs are machined with largest flat surface, used for location in subsequent operations, and after completion of part are cut off.)

low-alloy steels with suitable heat-treatment can often supplant more costly and difficult-to-machine alloy steels.

Design for Minimum Number of Separate Operations in Machining, Finishing, Forming, Molding, Casting, or Assembling. Quite naturally, the fewer operations necessary to complete a part, the lower will be the cost. Needless fancy extraneous portions which require extra operations, should be recognized and deleted. Recognition of the many and oftentimes difficult problems encountered in designing adequate tooling to handle a specific job is imperative if ultimate parts costs are to be minimized to any extent. Where sharp corners would create tooling problems or result in stress raisers, these also should be recognized and eliminated before a design reaches the production stage. All design features of a part should be scrutinized carefully to be sure the tools can reach the desired points, that the tooling needed is the simplest possible, and that special operations are not required.

It is of primary importance in mass production to reduce to a minimum the number of directions from which a casting, forging, or other part must be finished. Frequently, if considered during early stages of design, it is possible to put finished openings, threaded holes, and other features in the same plane as the major machining operations and allow completion of the part at one setting.

Actually, the greatest savings which can be obtained in designing for production usually result from reducing the number of separate processing operations required to complete a part. Next in importance is reduction in the number of parts used, and following that comes savings effected through use of stock parts or interchangeable parts.

The hydraulic-cylinder design shown in Fig. 3 is an excellent example of how this and the previous principles of designing for production can be applied. Actually, the number of operations required to produce the various parts of this item were reduced from a total of 45 to 21. The operations were simplified, and greater use made of automatic equipment. Total number of parts was reduced from 14 to 10 and the resultant cylinder was 40 per cent lighter, had the same capacity and operating pressure, 1500 psi. Cost was reduced from over 40 to less than 7 dollars.

Design for Ease of Holding, Setting Up, and Handling Parts. Where parts must be held or located in a jig for a processing

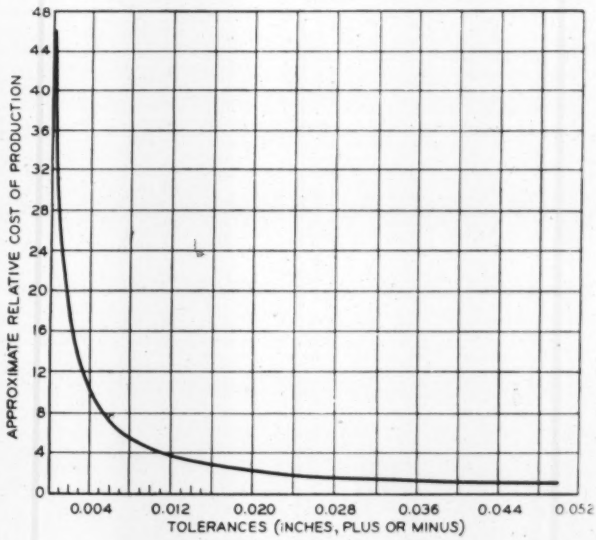

FIG. 9 CHART OF GENERAL COST RELATIONSHIP OF VARIOUS DEGREES OF ACCURACY

(Plotted from a variety of data, trend is only indicative of cost of refinement and does not take into consideration possibilities offered by judicious designing for production.)

operation, consideration must be given the means by which the operation will be accomplished. Lugs may be added, contours changed, or sections varied slightly to make handling a simple rather than a costly operation. Much as with tooling, jig and fixture problems, resulting from some needlessly complicated designs, become insurmountable in an attempt to achieve mass production. Some degree of understanding of the processing functions involved in each method, as well as an appreciation of the various aspects of fixturizing, holding, or feeding the parts, can achieve vastly improved production, lowered jig or fixture costs, and of course reduced production cost per part.

Difficulty of handling certain parts in production is often overlooked. Pads or locating positions are almost invariably

required in processing, regardless of quantity. Use of false lugs for locating and clamping often may be a necessity. Where conditions indicate, such lugs should be designed so as to be cast integral with the part and located so that, following completion of the machining operations, they can be cut off readily and destroyed, Fig. 8, without affecting the part.

Specify Finish and Accuracy no Greater Than That Commensurate With Type of Part or Machine Being Designed and Production Method or Methods Contemplated. Tolerances on finish and dimensions play an important part in the final achievement or absence of practical production design. A comprehensive study of the principles of interchangeable manufacture is absolutely essential for thorough understanding and full appreciation of low-cost mass-production technique. Interchangeability is the key to successful mass production, and details of all parts should be surveyed carefully to assure not only inexpensive processing but also easy rapid assembly on the production line.

Knowledge of the inherent variations present in each process which set the economical dimensional-tolerance limits and surface finish obtainable completes the picture from a practical standpoint. It can be said, almost without reserve, that the specification of close tolerances without serious consideration of all the factors attendant to maintaining them in production invariably will result in needlessly excessive or prohibitive costs from slowed output, extra operations, high tool upkeep, and high rejection or scrap losses. Any tolerance less than plus or minus 0.005 in. should be scrutinized closely to be sure such is absolutely essential, and then the tolerance selected should be compared with the normal average usually produced with the processing method contemplated. If the process cannot be relied upon for the accuracy or surface finish required, the part must be redesigned for another more suitable method, or, where increased costs can be absorbed, additional refined processing operations sometimes can be utilized to obtain the desired result.

A general idea of how machining tolerances compare as to relative cost of producing and holding them is illustrated graphically in Fig. 9. Naturally, as operations are added to gain refinement of tolerances and surface finish, costs increase. This chart is intended only to portray the general cost relationship of various degrees of accuracy, but the importance of judicious selection and specification of tolerances can be seen readily. Actually, each process must be analyzed individually

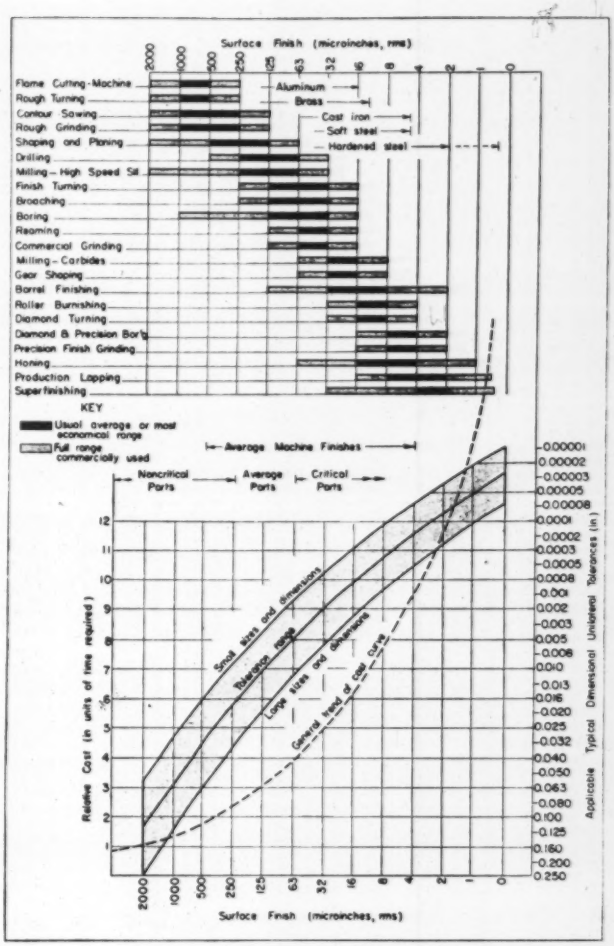

FIG. 10 CHART SHOWING BASIC METAL-REMOVAL PROCESSES, THEIR OVER-ALL AND NORMAL COMMERCIAL RANGE OF SURFACE ROUGHNESSES, AND THEIR ACCOMPANYING RANGE OF PRACTICAL DIMENSIONAL TOLERANCES

(Rational tolerance ranges shown are merely indicative and should not be applied directly without adequate study of particular process under consideration.)

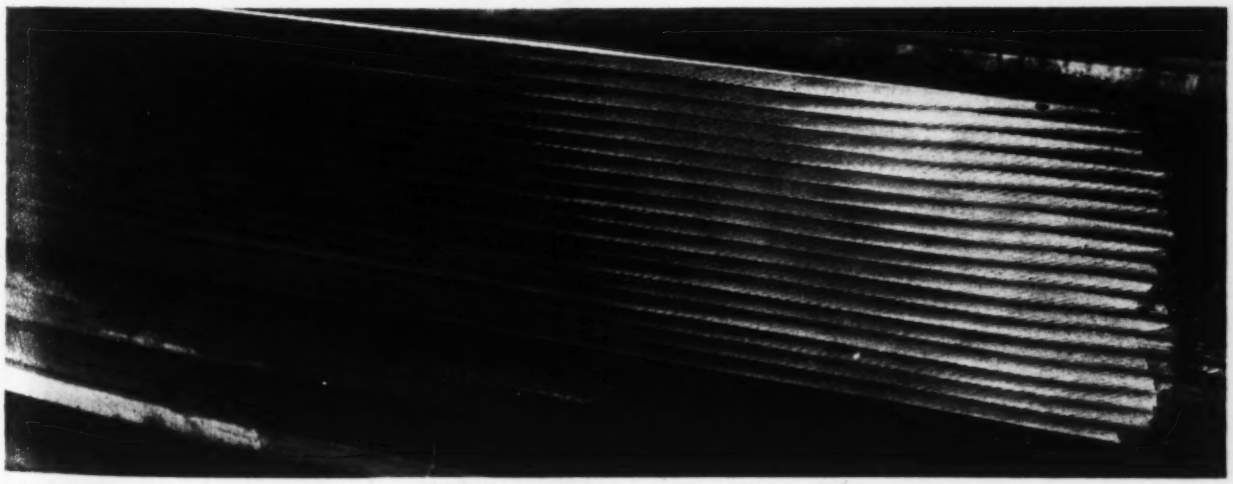

FIG. 11 SLIDEWAY FOR TURRET-LATHE BED EXHIBITING WELL-CHOSEN CROSS-DIRECTIONAL SCRATCH PATTERN FOR LUBRICATION

(Where movement is slow and surfaces operate under heavy loads, a scratch pattern designed to help break up continuity of scoring will prolong service life of such units. High-speed sliding members having proper lubricant probably would have little need for a scratch pattern.)

along with the particular part, inasmuch as by designing particularly to suit a specific process, the desired degree of accuracy often may be obtained without undue cost penalty.

Generally speaking, fine surface finish and close tolerances do not result with operations where metal removal is extremely heavy. Once the functional specifications for a particular part and the accompanying accuracy necessary to assure satisfactory performance have been determined, it is relatively easy to ascertain the production method or methods that will be required to produce the part. Once the production quantities have been determined, the possibilities are usually narrowed to but one or two alternatives depending upon design flexibility.

Neither dimensional tolerances nor surface quality should be specified to limits of accuracy any closer than actual function or design necessitates to assure the advantages of lowest possible cost and fastest possible production. The roughest acceptable finish should be contemplated and so specified. If at all possible the inherent average finish quality left by the basic production method required should be acceptable.

In Fig. 10 the basic metal-removal and finishing processes are charted with their full range of surface finish encountered in general commercial practice. Shown also is the narrower range of surface finish normally expected in average production which is not the very finest, but which can be anticipated with well-kept machines without incurring undue costs. Finish readings are in microinches, root-mean-square, taken on a profilometer and occur in the accepted preferred-number sequence.[4]

To provide at a glance a direct idea as to the general relationship of actual dimensional tolerances to surface roughness, the chart in Fig. 10 also indicates a range of accuracy for each processing method. That there must be some relationship between surface roughness and dimensional accuracy is of course obvious. To expect a tolerance of 0.0001 in. to be held on a surface finished to an average roughness of 500 microinches certainly is impractical. Since this reading indicates a roughness or actual peak-to-valley depth of roughly 0.002 to 0.0035 in., not considering characteristic waviness patterns, chatter, or feed marks which also affect the accuracy, this is self-evident. Owing to the many idiosyncrasies and ramifications which necessarily characterize all production methods, these charted figures should not be used directly in specifying part tolerances. Rather, they are intended only to be indicative of the practical or possible ranges. Each part designed should be considered separately along with the process contemplated, in order to obtain those benefits possible through careful adaptation to suit the peculiarities inherent in a particular method.

Again, in relation to surface finish, it must be remembered that each process produces its own characteristic type or types of surface-finish pattern. Finish specifications, where important, should not be general or contain loose phraseology susceptible of gross misinterpretation. Use of approved methods of specification will be found well worth while.[4] Functional requirements for a specific part should be carefully analyzed—it is possible to have too perfect a surface! Tableways, for instance, can be flat and smooth to the point that lubrication fails to separate the moving parts, Fig. 11. Hydraulic valves have been fitted so closely by lapping that, without benefit of a definite lubricant-retaining scratch pattern, they fail to function under normal system pressure after several shuttlings back and forth. In one case only a special extreme pressure lubricant saved the day. Characteristic range of surface-roughness figures shown in Fig. 12 will help judge as to what constitutes a practical finish. Careful study of the basic characteristics of each production method will provide a clue to the surface pattern to be expected and the suitability of the part so produced for the intended use.

[4] "Surface Roughness, Waviness, and Lay," approved method for indicating surface roughness values, waviness, and lay of pattern contained in Standard B46.1, 1947, of American Standards Association.

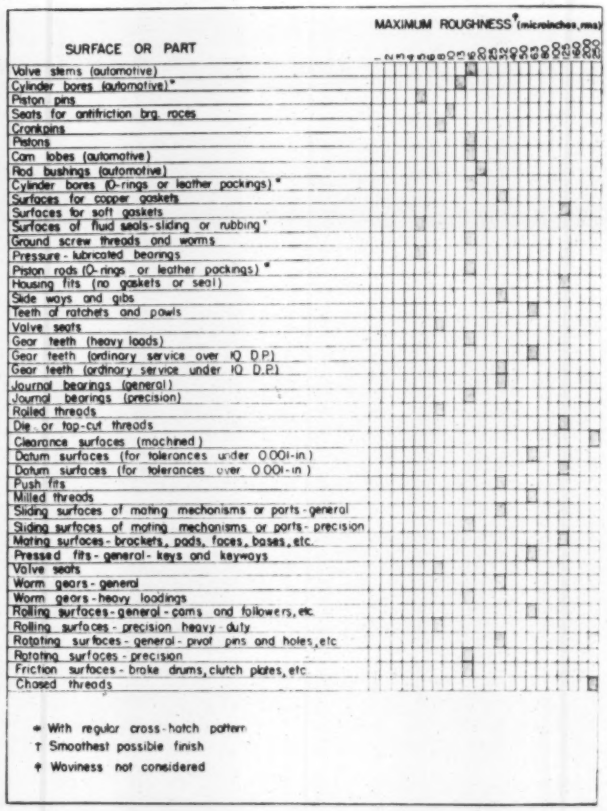
SURFACE OR PART
MAXIMUM ROUGHNESS* (microinches, rms)
Valve stems (automotive)
Cylinder bores (automotive)*
Piston pins
Seats for antifriction brg. races
Crankpins
Pistons
Cam lobes (automotive)
Rod bushings (automotive)
Cylinder bores (O-rings or leather packings)*
Surfaces for copper gaskets
Surfaces for soft gaskets
Surfaces of fluid seals-sliding or rubbing†
Ground screw threads and worms
Pressure-lubricated bearings
Piston rods (O-rings or leather packings)*
Housing fits (no gaskets or seal)
Slide ways and gibs
Teeth of ratchets and pawls
Valve seats
Gear teeth (heavy loads)
Gear teeth (ordinary service over 10 D.P.)
Gear teeth (ordinary service under 10 D.P.)
Journal bearings (general)
Journal bearings (precision)
Rolled threads
Die- or tap-cut threads
Clearance surfaces (machined)
Datum surfaces (for tolerances under 0.001-in.)
Datum surfaces (for tolerances over 0.001-in.)
Push fits
Milled threads
Sliding surfaces of mating mechanisms or parts-general
Sliding surfaces of mating mechanisms or parts-precision
Mating surfaces-brackets, pads, faces, bases, etc.
Pressed fits-general-keys and keyways
Valve seats
Worm gears-general
Worm gears-heavy loadings
Rolling surfaces-general-cams and followers, etc.
Rolling surfaces-precision heavy duty
Rotating surfaces-general-pivot pins and holes, etc.
Rotating surfaces-precision
Friction surfaces-brake drums, clutch plates, etc.
Chased threads
* With regular cross-hatch pattern
† Smoothest possible finish
‡ Waviness not considered

FIG. 12 CHARACTERISTIC MAXIMUM SURFACE-ROUGHNESS FIGURES FOR COMMON MACHINE PARTS

(Charted from present-day practice on such parts or surfaces, these data will assist in judging as to what constitutes a practical finish.)

CONCLUSIONS

Recognizing the economic possibilities and limitations of the various basic methods of manufacture now available thus becomes one of the most important considerations for the designer. Reduced manufacturing costs, simplified processing, decreased material waste, and design improvement must find their origin in the engineering department, and depend primarily upon the extent to which the parts have been "processed" or "designed for production," so as to lend themselves to manufacture at minimum cost.

ACKNOWLEDGMENTS

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COAL-HANDLING SYSTEMS *for* LOCOMOTIVES

By J. J. KANE

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COAL-HANDLING SYSTEMS OF THE PAST

ONE hundred years ago locomotive builders began to consider devices to improve the motive power of the day. Among the devices considered was a machine to fire a locomotive mechanically. No definite record can be found of the construction details of the device.

At the turn of the century, the record states that the first locomotive stoker to have any degree of success was the "Kincaid." This stoker was invented, designed, and developed by a Chesapeake & Ohio Railroad engineer named John W. Kincaid. The stoker was a coal-distributing device with a storage hopper mounted on the floor of the locomotive cab.

This first stoker did not relieve the fireman from shoveling coal, but rather complicated his duties. He not only had to shovel coal into the hopper, but he also had to regulate and operate the fuel distributor.

The development of the Kincaid stoker later brought about the so-called "Manifesto on Stokers." This manifesto was the outcome of the Railway Master Mechanics Committee ruling on stokers which not only condemned the hopper-type stoker but established a set of design rules for future stokers.

A few of the points emphasized by this manifesto were as follows:

1 The stoker must be entirely mechanical from tender to grate.
2 The capacity should exceed the locomotive requirement.
3 The distribution of coal should be accomplished without assistance from the fireman.
4 It should maintain an ideal fire.
5 It must assure reliability of service.

The stoker manufacturers and designers did not conform to the manifesto rulings to any great extent. Stoker designs offered were fixed and applicable to only one type of locomotive, making the same stoker entirely unsuited for other locomotives in the same service or other services. The stoker design made it necessary to institute extensive and costly alterations to the locomotive, in order to make a suitable application. The designers and builders worked on the theory that the railroads should revise the locomotive to suit the stoker instead of building the stoker to meet the characteristics of the locomotive.

During the period from 1900 to 1910, many stokers were invented, developed, and applied to locomotives. Of the many developed, only the Street, Fig. 1, the Crawford, and Hanna met with commercial success.

Between 1910 and 1920 a second development period took place, resulting in new names and designs in the stoker field. By 1920 the Standard Type A, Fig. 2, the Duplex D-1, Fig. 3, the Elvin, the Ayres, and the Dunning were among the new stokers introduced.

By 1920 the stoker had become an integral part of the loco-

Contributed by the Railroad Division and presented at the Fall Meeting, Erie, Pa., September 28–30, 1949, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

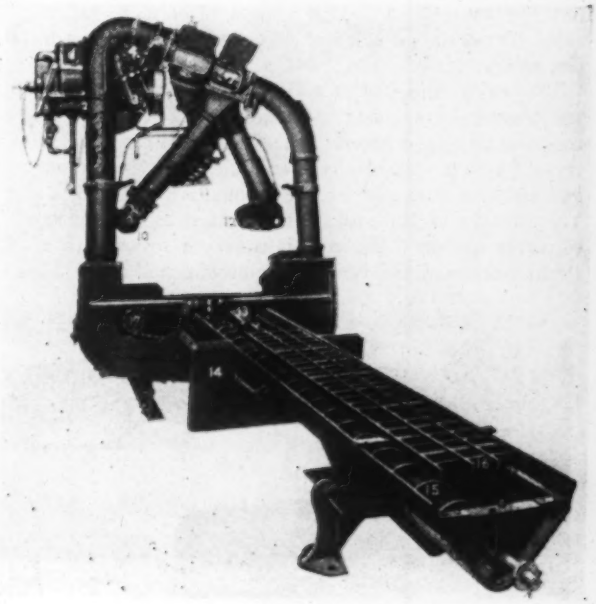

FIG. 1 LEFT SIDE VIEW OF STREET STOKER

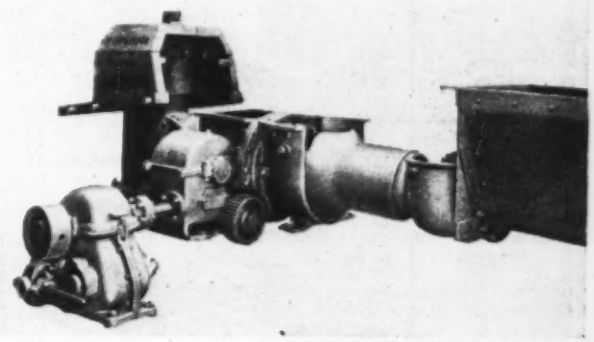

FIG. 2 STANDARD A-1 STOKER

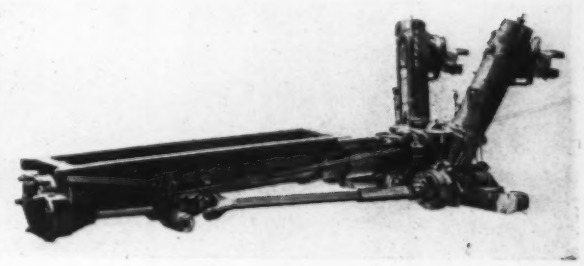

FIG. 3 SIDE VIEW OF D-1 DUPLEX STOKER

motive and was considered as the leading factor that enabled designers to build a larger more powerful locomotive. The period of the small grate area had passed, as the stoker made it possible to supply fuel at a sustained rate for any desired period of time.

Type B Stoker. Between 1920 and 1925 the first major simplification program was undertaken. The older successful stokers were improved during this period but the major simplification was the introduction of the Standard Type B stoker. This type stoker, with some slight improvements and variations, met the demand of the railroads for a simple, efficient, and reliable stoker, and it has come down through the years with further improvements. It is a standard on many railroads today. The Standard MB stoker is shown applied to a locomotive in Fig. 4.

The stoker consisted of a U-shaped trough, conveyer screw and crusher arrangement in the floor of the coal tender. The coal was conveyed between the engine and tender by a screw encased by a flexible slip-type casing which absorbed the angle and elongation caused by the locomotive rounding a curve. This section of the stoker is identified as the intermediate conveyer section. The coal is conveyed forward to a point slightly forward and beneath the firebox mud ring. Here the coal is forced around a curved elbow and into a near-vertical casing where it rises to a point sufficiently high above the fuel bed to permit distribution to all points of the firebox. The coal is distributed from the top of this vertical casing by controlled steam jets.

BK and HT Type Stokers. A second simple stoker, the BK type, offered for railroad approval, was a type which incorporated a vertical or riser conduit outside the firebox. This type stoker is still made and many are in use on present-day locomotives.

In 1933 a stoker was introduced which delivered coal from the tender to the distributing location by means of a continuous screw; the addition of an elevator screw in the riser conduit made this feature possible. This stoker, the Standard HT, Fig. 5, is mounted outside the backhead and fires through an enlargement of the regular firedoor opening. Many variations were offered along with this design which enabled the fireman to control the flow, delivery, and distribution of the coal. The flexibility provided with the HT stoker was accomplished with adjustable coal-deflector vanes, cutoff levers, and a variety of ribbed distributor plates.

To meet the flexibility requirement, all the foregoing control devices were introduced, and small, compact, and efficient

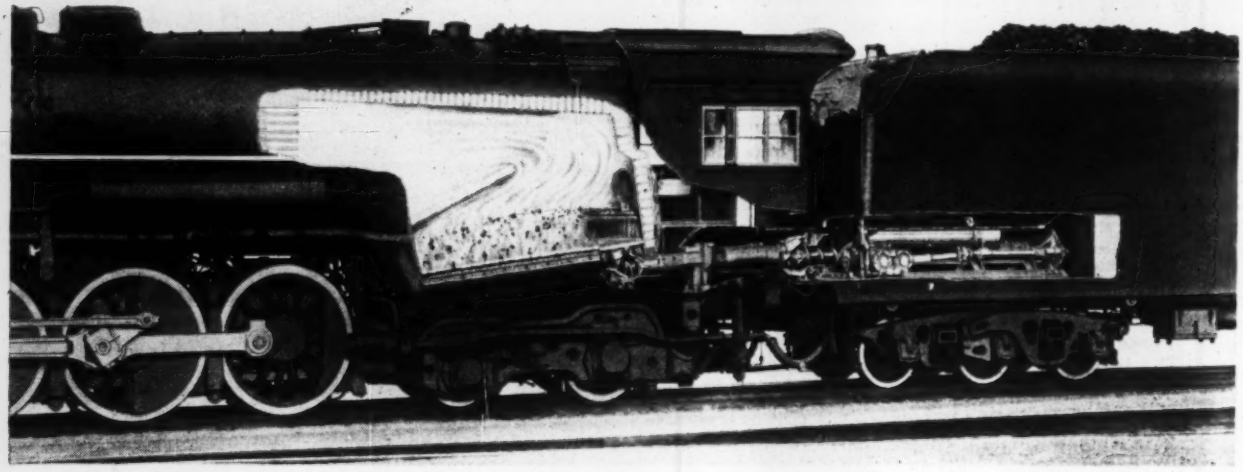

FIG. 4 STANDARD MB TYPE STOKER AS APPLIED TO LOCOMOTIVE

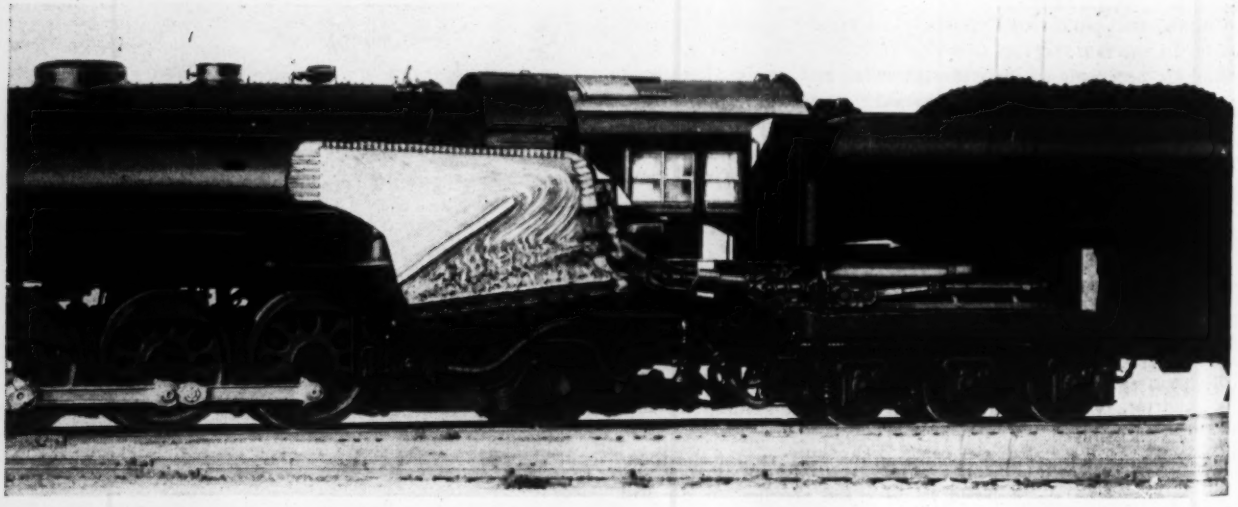

FIG. 5 STANDARD HT TYPE STOKER AS APPLIED TO LOCOMOTIVE

steam engines were developed to supply both conveying and coal-crushing power for the stokers.

PRESENT-DAY COAL-HANDLING SYSTEMS

Dual-Level Tender Trough. In considering some of the present-day locomotives, more recent stoker advances have been made which are considered highly successful.

A major advance in stoker design is the tender trough placed on the New York Central "Niagara" type S-2 locomotive No. 5500. This trough resulted from the trend of many railroads toward the elimination of some fuel stops, through the use of longer tenders having a greater coal capacity.

The "dual-level tender trough," Fig. 6, incorporates two screws operating on different levels, each screw being driven from a common gear housing at the rear of the trough. The length of each of these screws is equivalent to the normal and conventional length used in the average locomotive tender.

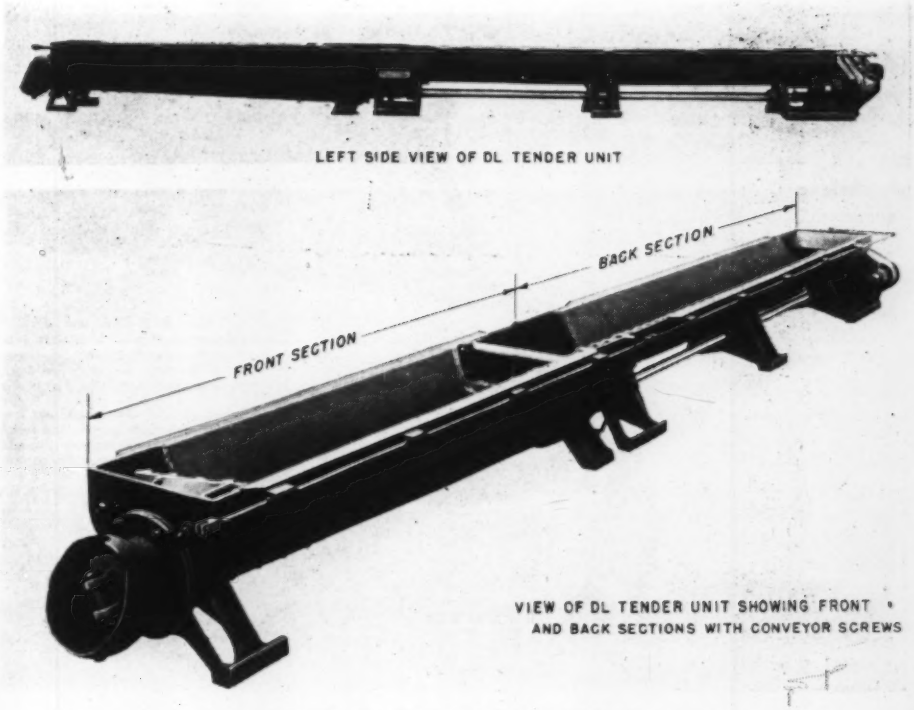
LEFT SIDE VIEW OF DL TENDER UNIT
BACK SECTION
FRONT SECTION
VIEW OF DL TENDER UNIT SHOWING FRONT AND BACK SECTIONS WITH CONVEYOR SCREWS

FIG. 6 DUAL-LEVEL TENDER TROUGH

Another feature of the trough is the dual delivery accomplished by operating both screws together or by disengaging the rear or upper-level screw. A built-in clutch in the gear housing is used to control operation of the rear upper-level screw.

A few of the advantages cited for this new stoker trough are as follows:

1 Better weight distribution of the coal over the conveying area.

2 Reduction of wear and high conveying loads. At no time is it necessary for a single screw to carry the entire load.

3 Flexibility of length will allow construction of large-coal-capacity tenders.

4 Construction and design offer extended dependability and long service life.

The record of the "Niagara" DL stoker unit is outstanding.

Automatic Stoker. A rather recent development to consider under present-day locomotive fuel systems is the automatic stoker applied to switching locomotives of the Norfolk and Western Railway, Fig. 7. The term automatic stoker distinguishes between these slightly modified stokers and the many similar designs which are in use on railroads throughout the country, and which normally are hand-controlled by the firemen.

The stoker applied to the Norfolk and Western Railway switcher retained the coal bunker-trough design, the flexible intermediate section, and the screw-type coal-elevation system. The steam-jet coal distribution was retained also, because of its simplicity and ease of control.

One of the main purposes behind the development of this stoker and the related controls along with an automatic feedwater supply and a mechanically drafted system, was to initiate a coal-burning switcher to compare favorably with other types of switchers. The switcher must be reliable, show high availability, be flexible, and yet show a low over-all operating cost.

The stoker, like the induced-draft fan, is controlled by a system actuated by boiler pressure. The main controller operates the stoker steam jets for coal distribution, and the stoker. The speed control for the stoker is accomplished by using a special hydraulic tachometer connected to the stoker engine through a V-belt.

To start the sequence of operations, a predetermined drop in boiler pressure, reflected through the controls, will start the induced-draft fan first, the stoker coal-distributing steam jets are second, and then finally the stoker coal-conveying system will start. To shut down the coal-supply system completely for a stand-by period, the reverse of the starting operation takes place.

Two of the modifications in the stoker over standard designs are (1) an extremely high gear ratio to assure smooth operation at low fuel rates, and (2) the accurately designed tender delivery screw that will meter the coal in relation to the air supply.

The improvements made to the locomotive by the addition of the automatic features make it possible to keep the locomotive in service for 24 hours a day with the exception of the time necessary to fill the water tank, clean the fire, and fill lubricators. The fueling of the tender is approximately once every 48 hours, depending upon the service performed.

COAL-HANDLING SYSTEMS FOR THE FUTURE

The development of a coal-fired locomotive to equal or better the operating performance, availability, and operating cost of the present Diesel locomotive is fast becoming a reality. The need for development of the coal-fired locomotive is quite evident because of the possible future scarcity of oil. The low cost, availability, the great power potential, and the vast supply of coal make it the ideal and economical railroad fuel.

Three research and development programs are now under way to advance the status of the coal-fired locomotive. Each

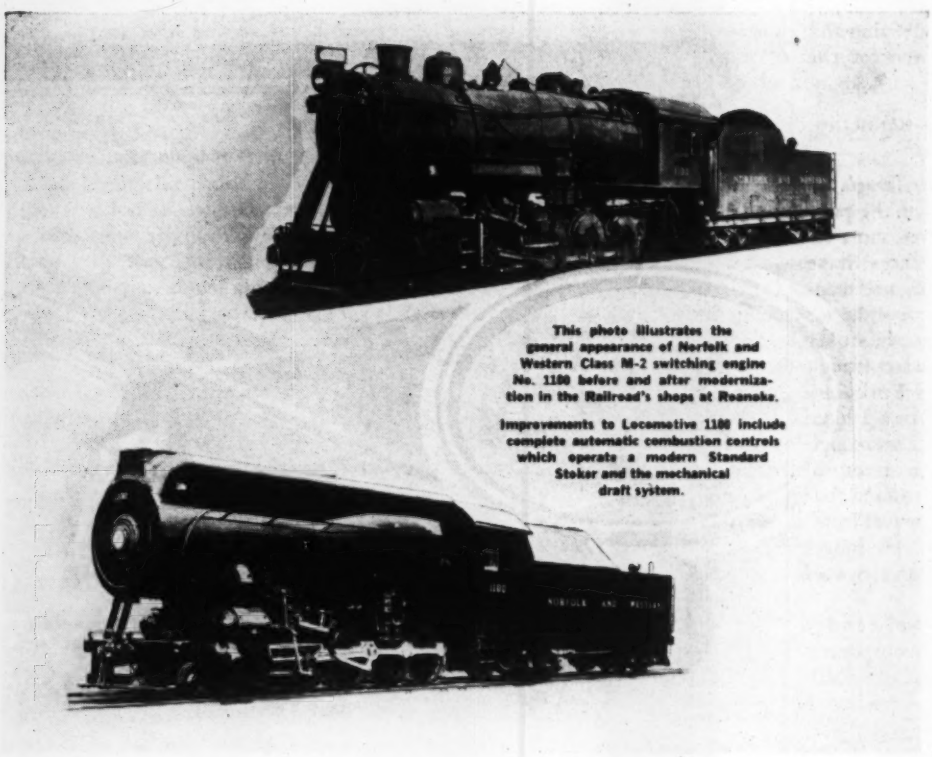
This photo illustrates the general appearance of Norfolk and Western Class M-2 switching engine No. 1180 before and after modernization in the Railroad's shops at Roanoke.
Improvements to Locomotive 1180 include complete automatic combustion controls which operate a modern Standard Stoker and the mechanical draft system.

FIG. 7 AUTOMATIC SWITCHING LOCOMOTIVE NORFOLK AND WESTERN RAILWAY COMPANY

program is attacking the problem from a different view. This is positive assurance of the need for a new coal-fired locomotive. Although three development programs are under way, only two basic locomotive designs are being considered, namely, the gas turbine and the steam turbine, both combined with an electric drive.

The gas-turbine power unit is being approached from two angles: (1) using coal to produce gas, which in turn is burned for the turbine energy supply, and (2) burning pulverized coal under pressure in new radical combustors with direct air supply to furnish energy for the gas turbine.

In the steam-turbine program, the use of the water-tube boiler, pressure furnace, and complete combustion controls are features involved in present designs.

With regard to the fuel-handling system for these locomotives, the first consideration is the extremely low hourly fuel demand. The proposed steam turboelectric locomotive will use approximately 6500 lb of coal per hr at the maximum operating condition, while the gas-turbine units will demand between 4000 and 4500 lb per hr at their highest operating rate. These low fuel rates combined with coal conditioning, pulverization, evenness of supply and feed, and the pressurized system of combustion set forth new and challenging demands on the coal-handling system.

Steam-Turbine Locomotive. The coal-handling system for the steam-turbine locomotive is by far the simplest of the three arrangements. This system utilizes many of the past stoker features, but the knowledge and experience of the past will be combined with some new and recent features to produce a modern efficient coal-handling system. The unit consists of a trough section quite similar to that now in use on coal-fired locomotives, and a rather long screw-conveyer unit to deliver coal to a simple discharge head mounted on the firebox. The coal is distributed into a firebox which is under slight pressure (approximately 1 lb) and on to a slowly moving self-cleaning grate.

The coal system will be sealed to enable the firebox pressure to be maintained. To accomplish this seal, a special moving coal plug is created and maintained in the discharge head with any type and kind of coal supplied to the locomotive.

Extensive use will be made of automatic controls to operate and regulate the coal-handling system. These controls have been developed and have proved very successful, as discussed in connection with the stokers of the present.

Gas-Turbine Locomotive. The gas-turbine development programs present new and radical problems which must be overcome to provide the somewhat predetermined coal-handling system. This so-called predetermined system is the direct result of the new combustion principles involved in producing heat for the gas turbines. Some of the predetermined features may be considered as the need for dry coal, the need for sized and pulverized coal, and the use of pressurizing feeding devices since the coal must be burned under pressure.

The first of the coal-handling systems for gas-turbine locomotives stems from the program undertaken by one of the larger locomotive builders. The successful road tests and overall operation of the oil-fired gas-turbine locomotive indicated a place for a locomotive of this type to burn coal.

Gas-Fired Combustors. To use coal for fuel in a similar gas-turbine power plant, the coal first must be converted to produce gas which will be burned in combustors which supply working fluid for the turbine.

Two small gas producers, each having a maximum coal rate of about 1 ton per hr, are necessary to operate a 4000-hp gas-turbine locomotive. These gas producers operate under pressures of about 80 to 90 psig, which in turn will require a pressurized coal-feed system.

This system will include a somewhat conventional stoker

type feed system from a closed bunker, a rotary-type crusher to prepare the coal for a pressurizing unit, and a screw-feed system under pressure to deliver coal to the producer.

Many of these parts are quite familiar, although the one and most important part, namely, the pressurizing unit, is a new development.

Coal-Pressurizing Unit. The pressurizing unit was developed for use in materials-handling systems requiring a continuous material feed from atmospheric pressure to any desired higher pressure.

This unit plays an important function in the system and is also being considered for use on a locomotive being developed and built by the Locomotive Development Committee.

A simple explanation would be that it is a continuous-lock hopper system created by two hydraulically operated cone

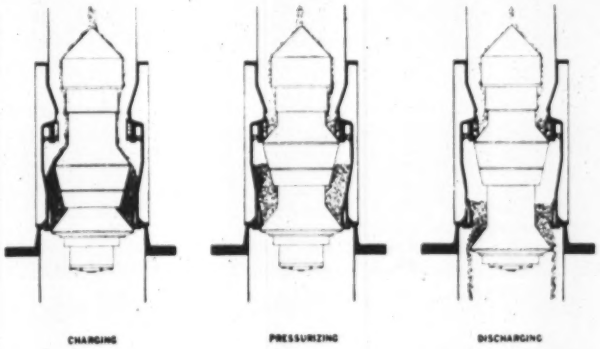

FIG. 8 STANDARD STOKER PRESSURIZING UNIT—SEQUENCE OF OPERATION

valves seating on rubber or similar material in a single valve body, Fig. 8.

This unit, as built for the gas-turbine locomotive, will pressurize up to 7500 lb of coal per hr to a pressure of 200 psig. The coal size can vary from 100 per cent—$^3/_4$ size to 300 mesh. The speed or cycles per minute also can be controlled, and the operating range can be between 1 and 5 cycles per min.

Construction centers about a large pressure-type casting which contains the pressurizing and exhaust ports, the locations for the inserts containing the rubber seats, and the support for the entire inner valve assembly. The inner valve assembly is made up of the two cone valves, a housing that serves as both support and guide, the seal packing, the hydraulic cylinders, and holding means for each cone valve. On the outside of the valve body are two small valves, one used for a chamber pressurizing valve, the other used as the chamber exhaust valve. Two four-way hydraulic valves are used to control the cone valves. All four of these valves are operated by cams mounted on a short shaft operated at the desired cycle speed. A compact low-pressure hydraulic unit is used to supply power for operating the two cone valves.

The operation cycle of the unit is started by opening the upper cone valve to allow a charge of coal to flow into the chamber. The valve is then closed to make contact and close on the upper rubber seat. As this valve is closing, it contacts and lifts a metal ring which serves as a protector for the rubber seat. After the upper valve has closed, the chamber pressurizing valve is opened to admit air to bring the chamber up to and slightly above the actual discharge pressure. After pressurizing the chamber, the lower cone valve is opened to allow the coal to discharge. The chamber pressurizing valve remains open for a few seconds while the lower valve is open. This higher-pressure air is discharged from small jets around the valve body to sweep out the chamber thus assuring complete discharge. This chamber pressurizing valve is closed before the lower valve is closed.

After the lower valve has closed, the chamber exhaust valve is opened to vent the chamber back to atmospheric pressure. This completes one cycle of operation as the upper cone valve opens immediately after the chamber is exhausted.

A few additional comments on the pressurizing unit may be considered at this time as they were not brought out in the sequence of operation. The use of a low hydraulic pressure is an outstanding feature as the cone valves never have to open or operate against high pressures. The hydraulic system is used to assure positive action, provide a slight pressure when seating the valves, and allow smooth power in both directions. The power required is more or less used to lift and seat the valves.

The seal between the two valves is accomplished by packing which is covered and protected from any contact with the coal as it passes through the unit. The seats are made of rubber bonded to removable metal rings which can be changed easily in the event of wear.

The location of the seats is such that the coal never touches them when it is flowing into or out of the chamber.

Complete Coal-Handling System. Returning to the complete coal-handling system for the locomotive, the entire system more or less centers about the coal-pressurizing unit, although a brief explanation of the other parts and their purpose and function is necessary. The coal will be delivered from a closed bunker by a conveyer trough similar to the present stoker trough and will be conveyed by a screw to a rotary-type coal crusher. Here the coal will be crushed to a $^3/_4$-in. maximum size to allow passage through the coal-pressurizing unit. The feed to the pressurizing units will be handled by small independent conveyer screws controlled by a level control in the gas producers. The pressurizing unit will be operated at a constant speed or cycle as the coal feed to the pressurizer will be controlled.

A small pressure hopper with a short screw is used under each pressurizing unit to even out the feed to each gas producer. This small hopper and feed screw form the only section of the entire system that is under pressure.

One additional feature of this feed system is that any type coal, either wet or dry, run-of-mine or slack, can be used without difficulty or without creating any additional load on the system.

Coal-Fired Combustors. The Locomotive Development Committee is investigating and working on two completely different coal-handling systems in connection with its locomotive-development program. Once again the nature of the combustion principles and the combustors to be used tend to predetermine features of the coal-handling system. The combustion principles and the combustors under development indicate the coal will be burned under pressure at very high combustion efficiency. Extremely fine pulverized coal will be used, and it will be delivered to the combustors in a pressurized conveyer system. The two systems under investigation and development are the pressurized mill system and the atmospheric mill-and-supply system.

One common feature of both these systems is the combination bunker-feed conveyer and coal drier. This feature is one that has been somewhat predetermined.

The need of dry coal in the pulverizer and pressurizing devices makes it necessary to furnish a continuous and compact coal-drying system that is actually built into the coal-handling system.

The coal-handling system for the gas-turbine locomotive will have to process and deliver coal that will be provided to the locomotive from present-day coaling facilities. No special

treatment will be accorded to this locomotive, and the system will have to handle wet, dry, lump, or slack coal.

Coal-Drying Trough. To supply the dry coal, a special bunker delivery trough was developed which incorporates a continuous coal-drying feature. This trough employs the dual-level, two-screw feed system, used so successfully on the New York Central Railroad, combined with a double-ribbon-type screw-feed conveyer that is used in the drier section.

In any explanation of this trough drier unit, the over-all size must first be considered. The bunker capacity was set at 17 tons, and the resulting coal opening to the trough is 17 ft. The over-all length is $24\frac{1}{2}$ ft, while the width and height are approximately 3 ft. The unit is designed to handle and supply 6000 lb of dry coal per hr when operating under extreme conditions.

The entire assembly is of welded construction, although the main gear housing and the smaller gear housings are castings. The trough delivery screws are cast, while both drier screws are of fabricated design. The unit is constructed of two separate sections and is joined in the center where the trough levels change. The two-drier tube principle had to be used to meet the requirements for drying when operating with coal of high moisture content. The two ribbon screws agitate the coal as it is being conveyed forward. At the forward end of the unit a screw-type elevator is applied at the end of each drier tube. A large cross-sectional area is used in the drier section to reduce drying-air velocity, thus reducing the amount of fine coal that would be carried out by the exhausted air. The entire unit is well insulated, and all parts that require protection from the heat were moved out to locations where they will remain cool.

The operation of the unit is simple. Power is supplied by a compact hydraulic motor to insure smooth, powerful, and well-controlled operation. The flow of coal is somewhat reversed from the normal feed systems. The coal is first brought to the rear of the trough by the dual-level conveyer screws, where it is then divided and dropped into the drier. The coal then starts forward through the drier against the flow of the drying air. When the coal reaches the forward end of the drier, it is conveyed through a cone-shaped section into a small elevator screw, delivering to either the storage bin or the roll-type crusher.

Atmospheric-Mill System. In considering the atmospheric-mill supply system, the coal as it leaves the drier elevator screws is delivered into a storage bin equipped with a feed screw to supply an atmospheric coal-pulverizing mill. The storage bin will provide storage for about 1 ton of coal to be used in case of trouble with the bunker feed system.

The pulverizing mill is equipped with a classifier to hold the coal in the mill until it reaches the proper fineness. The coal is removed from the mill by an air stream which also conveys the coal to a coal-separator unit to separate the coal from the air stream, thus allowing recirculation of the conveying air and storage of the pulverized coal.

The coal is removed from the second storage bin by a controlled feeder which will meter the coal to a rotary coal pump which delivers the coal from atmospheric pressure to the high combustor pressures.

At this point it might be well to consider each part of the system and some of the problems involved.

The crushed-coal storage bin, the feed to the mill, or some features of the mill cannot be considered as problems. The real problem of the system centers around the coal separator, metering and feeding devices, and the rotary pressurizing pump.

The separation problem is difficult for two reasons: (1) extreme fineness of the coal, and (2) the restricted space for a separator. This problem, created by the conditions which exist because of the type of coal required and the locomotive-cab design, again predetermines some of the coal-handling equipment. Work is now progressing on the development of an efficient and compact separator which will satisfy the existing conditions.

The metering and feeder device is the critical part of the entire system as an exact feed and constant supply of coal must be maintained for the combustors. No lag or delay can be tolerated as the combustor flame would die out. The exactness of feeding is not definite at this time, but present indications point to the necessity of a high degree of control.

The coal is delivered from the metering device directly to the rotary-type coal pump used to supply coal from atmospheric pressure to the high-pressure air line which feeds the combustor.

Rotary Coal Pump. The coal pump is made up of a 12-in-diam rotor (with 18 small pockets) encased by two outside casings and a circular section which closes the periphery of the rotor. The side casings serve as bearing holders, seal holders, and the pump supports. The exactness of the fit between the casing and rotor periphery and the use of seal rings pressed against the face of the rotor prevent air leakage.

Coal is fed to the pump down through a feed opening at the top of the center casing where each pocket fills with coal and carries it on around to the discharge point. The discharge point is located at the bottom of the pump and is the pressure air line which supplies the coal to the combustor. Coal is swept out of each pocket as it passes the air-line opening in each side casing. Any air trapped in the pockets is discharged through vent holes in the center casing.

This rotary coal pump has operated successfully under full-scale turbine and locomotive conditions, and only slight improvements will be necessary to make it a fully dependable unit for the coal-supply system.

Pressurized-Mill System. In the pressurized-mill system, the coal delivered from the drier elevator units is crushed to a $\frac{3}{4}$-in. maximum size by a roll-type crusher mounted on top of a storage bin. This storage bin not only serves as the crusher support but will provide assurance of fuel for about 1 hr of operation in the event of trouble in the bunker-feed system.

The coal is removed from the bottom of the bin by a small delivery screw that again elevates the coal to the coal-pressurizing unit.

The construction and operation of this pressurizing unit were fully explained in the discussion on the coal-supply system for the pressurized gas producers.

The pressurizing unit will deliver the coal to a small hopper where a controlled conveyer screw under pressure will supply the mill. The mill to be used in this pressurized system is similar to that used in the atmospheric system. Coal from the mill will be controlled by a variable air supply of somewhat higher pressure than normally used in the combustor.

By controlling the air from the mill and the speed of the feed screws, a definite fuel control can be maintained to satisfy the requirements of the combustor.

SUMMARY

From the explanation of the coal-handling systems for the gas and steam-turbine locomotives, the outstanding features to be pointed out are: (1) The systems are more radical and complicated than any fuel-handling system used in present locomotive service; (2) no rigid or fixed patterns were or are followed to handicap any possible development; (3) all systems show the full co-operation between the equipment and locomotive builders; (4) all present equipment and that being developed will be considered for constant simplification and improvement to assure complete dependability and performance.

CIVIC RESPONSIBILITY *Is* EVERYBODY'S BUSINESS *Now*

By K. B. McEACHRON, JR.

MANAGER, TECHNICAL EDUCATION DIVISION, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y. MEMBER ASME

FROM its very beginning the engineering profession has recognized the responsibility of the engineer as a citizen and has been concerned with civic problems. Engineers have been particularly active in local community problems, where projects of an engineering or technical character were being considered. In many communities engineers, as a group, have made significant contributions to the solution of such problem as traffic planning, stream pollution, or school construction. In our preoccupation with such local and immediate problems, we have often failed to sense the increasing scope of social and economic legislation. Because such policies are almost exclusively national in character, and their conception and execution seem remote from us as individuals, we seldom consider them to be a definite part of our civic responsibilities. Furthermore, we often regard government, and particularly Federal Government, as a nebulous force over which we as citizens have little control, except possibly at election time. The fact of the matter is, however, that over any very long time and in our democracy even in a shorter time, national policies must and do reflect the will of the majority. We have only to examine history even briefly to become aware of this guiding principle.

EARLY PHASES OF GOVERNMENT BY MINORITIES

When governments were first organized, they usually were controlled by small strong minorities—the "elite"— and operated very largely for the benefit of those in control. But as education and knowledge began to replace superstition and ignorance, the average citizen no longer would accept the principle of the "divine right of kings" or government by nobility. Beginning with the Magna Charta in 1215, and extending beyond the American and French revolutions, the farmer, the merchant, the peddler—in short, the common man—has rebelled to establish a more liberal government where every man has the same basic rights and privileges. Each person is free to develop as far and as long as his abilities and talents will permit. Only when he interferes with the rights or privileges of others is he limited or restrained.

There is now, however, strong pressure from the public to force another basic change in government—to create a dictatorship of the majority just as effective and potentially certainly as destructive as rule by any despot of history. Through ignorance and misunderstanding, often deliberately created, large segments of our citizenry have become convinced that the most effective way they can better themselves is by establishing a collectivist or socialistic state where average performance and reward are forced on everyone. In practice the principal emphasis is negative—upon discouraging those who would forge ahead to force them down to the average rather than encouraging the less qualified to bring them up.

But the real danger lies in the gradual way in which such a change in government occurs. It is almost impossible to point to a particular proposal and condemn it alone. Thus the proponents of this or that plan which contemplates tapping the national treasury can argue with some merit that this objective, whether it be support for education or socialized medicine, is desirable and does not by itself constitute collectivism. It is rather the extent of this creeping paralysis—the total portion of national income devoted to such purposes—that is significant.

When former President Hoover, speaking recently at Stanford University, stressed this point when he might well have discussed some aspect of engineering education, we can be sure the problem is immediate and serious. "There is a very considerable group of fuzzy-minded people," said Mr. Hoover, "who are engineering a compromise with all of these European infections. They fail to realize that our American system has grown away from the systems of Europe by 250 years. They have the foolish notion that a collectivist economy can at the same time preserve personal liberty and constitutional government. That cannot be done."

Granting that our civic responsibility as engineers does encompass the area of the economic and social policies of our national government, and that problems in these areas are serious and immediate, what then is our obligation as citizens and as members of this Society?

GOVERNMENT IS A PERSONAL CHALLENGE

We must stop thinking of this problem in terms of political parties and election returns. Even a cursory glance at the last year's campaign platform of either major party will show how similar were their pledges for more extensive government services—in fact each seemed to be trying to outdo the other. No, the principal point of attack is hardly through political parties or election campaigns. We must be realistic—government in a democracy will and must be responsive to what its citizens want regardless of whether what they want is good or bad. If we have government then, which is bad for us—and I mean for all of us from the truck driver to the banker—we have only ourselves to blame and only ourselves to look to for help. Here then is an individual obligation and a personal challenge. Only as each one of us becomes an effective salesman for economic democracy will we turn the tide of misunderstanding and ignorance which threatens to sweep over us.

Therefore, we must take every opportunity to correct unsound ideas in all our personal contacts, whether with taxi driver, barber, grocer, or banker. We must help to disillusion our fellow citizens about the possibilities of ever really getting "something for nothing" whether from industry, government, or anyone else. We need to regard with a healthy skepticism—and persuade others to do likewise—the economic panaceas that we are constantly urged to adopt. What idealism without practical understanding can cause is well documented in history.

A striking illustration is that provided by Diocletian, a Roman dictator of the third century. Filled with the desire to maintain employment and provide a high standard of living for all, he fixed wages and prices and generally attempted to

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legislate economic security. Before long, the very people his policies were attempting to help refused to work at their assigned tasks, and the resulting collapse laid the foundation for the final destruction of the Roman Empire itself.

This selfsame conviction that somehow by legislation we can create more for all of us than we can by working for it underlies most of our economic day-dreaming. But we can dispel this cloud of misunderstanding in the same way in which it was created—by individual contact and persuasion—if we will.

Furthermore, we can pool our efforts to provide better economic education for ourselves and those entering the profession than we have yet had. I believe it would surprise all of us if we could measure the economic understanding of the average engineer. We have the mistaken impression that, because we are concerned with facts in technical areas, we are also extremely practical in other fields. I doubt, however, that we are much less susceptible than the average citizen to sugar-coated economic propaganda—it's so easy to believe. In those instances when we do raise questions, few of us have any effective arguments to support our convictions.

Still less prepared to understand and reach conclusions about economic problems are the engineering undergraduates in our American colleges who will shortly become engineers. Here is a project, then, which might well extend through all the sections and student branches of the Society and combine the best efforts of those in education and management.

That formal courses in economics do not provide the needed understanding becomes obvious when recent engineering graduates are found to be largely ignorant concerning practical economic situations arising daily in industry. Bridging the gap between industry and education as it does, the Society has a unique opportunity to establish a regular program of discussions on current economic problems, both local and national, and to suggest qualified men from industry and business to lead such discussions. What formal courses in economics have lacked more than any other one thing is the practical, down-to-earth approach of men with actual business experience. The simple, direct, and convincing illustrations of what economic freedom really means such as those described in the motion-picture short, "Letter to A Rebel," are worth more than any economic text, in demonstrating what kind of economic system we have developed in America.

COMPANY EXPERIMENT IN ECONOMIC EDUCATION

For some time, in the author's company, a series of lectures and discussions of how our economy actually works has been conducted. We became convinced that most of the job dissatisfaction of industrial employees is only an outward manifestation of their inward doubts about our whole economic system. They believe, or have been persuaded to believe, that this present system of ours is working against them rather than for them—that neither management nor stockholders, nor any other group is on their side. It is little wonder that there is so much pressure for change to any other scheme thought to be more favorable—more nearly "fair." To this end, we have been working with all of our supervisors to provide them with the economic information they need to discuss the questions raised by their people. This economic education has been enthusiastically received not only by supervisory personnel but also by our professional employees to whom it has been extended. This year we are instituting a similar series of discussions on economic problems for our newest technical employees.

Our experience has been so favorable that I am sure a coordinated plan for a similar series at section and branch meetings would be even more stimulating than the regular program.

But we should be guilty of oversimplification if we went no further. Behind all the economic and political proposals which are being made constantly, there is an underlying urge for security and job satisfaction beyond that which we have today. As this urge drives each of us to provide for himself and his family, it promotes progress for all. But as the responsibility for providing such security is transferred from the individual to another or to government, confidence in government replaces self-confidence, dependence replaces independence until maintenance of the security provided by government becomes more important than freedom, whether economic, political, or finally even religious freedom.

Thus although the reduction in the standard of living which has always resulted from forced redistribution of wealth is serious enough in itself, the real danger is much greater and far less understood.

ADVANTAGES MUST BE EARNED

Even though we recognize some of the potential hazards in widely held economic misconceptions, we are often less sensitive to situations much closer to us which destroy independence and kill ambition and initiative. I doubt, for example, if there is a single reader who has not at some time vowed that his children should have an easier time of it than he had. Where such a natural wish is not balanced by an understanding of the damage to character and personality of continuous subsidy, "from shirt sleeves to shirt sleeves in three generations," will certainly apply.

In reviewing the engineering graduates in our company, we have been struck by the comparison between those who have largely earned their way through school and those who have made good scholastic records in college. Taking any cross section of these men, we have found that the 9 per cent who earned 100 per cent of their expenses, stood at the top of their class, the 26 per cent who earned between 75 and 100 per cent in the top quarter, the 30 per cent who earned between 50 and 75 per cent in the second quarter, and the 11 per cent who earned none of their college expenses in the bottom half. The scholastic standings of the group selected always show a direct correlation with the proportion of college expenses earned.

Whether it's a college education or medical services, the value placed upon each is in proportion to the extent it has been earned. It is reported that the only change England would propose in its socialized medical program, is to make some charge for service rendered! Having sold the common people on the efficiency and low cost of government ownership, English officials now complain that the public has no conception of the cost of government-provided services!

EXTENDING GOVERNMENT SERVICES ENDANGERS DEMOCRACY

As a people and as individuals, we too often fall into the habit of giving to this or that person, cause, or country without due recognition of the forces thereby set in motion to substitute dependence for independence, and eventually slavery for freedom. Similarly, in extending government services to more and more areas, we are so strongly influenced by our natural wish to help others that we ignore the increasing danger to democracy.

But the time is running out during which this trend can be reversed. Perhaps we have come to the point of decision already—many believe we have. We must recognize, and help others to learn, that economic democracy and political democracy are inseparable. We have gone to war more than once to preserve the one, but we may well lose them both without even being aware of what is happening until it is too late. What road America will travel rests with its citizens! Only as we as individuals challenge economic fallacies wherever we find them, and work to develop throughout the engineering profession a new understanding of economic problems will we help to decide what road that shall be.

Trends in
INDUSTRY-WIDE BARGAINING

Its Impact on Labor-Management Relations

By HIRAM S. HALL

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HISTORY OF INDUSTRY-WIDE BARGAINING

INDUSTRY-wide bargaining and, more recently, multiple-employer bargaining has and is having a profound influence upon our socioeconomic philosophy. The historical development of these two powerful mass unit groups has extended over many years, and the significance is such that the thoughtful student of labor-management relationship must early recognize the danger if certain of the trends revealed continue.

The growth of multiple-employer units has been in two directions: The first and earliest—via industry-wide bargaining; and the later and much more rapidly growing—bargaining by regional, metropolitan, city, and county associations.

A number of industries have had a very long history of industry-wide bargaining. For example, in the pottery and glassware industry, the glass blowers for years bargained for skilled workers on rates and wages, although unwritten laws pertaining to working conditions were developed gradually. Technological changes in the industry forced the glass blowers craft unions to abandon their traditional bargaining for skilled craft workers and resulted in their taking in semiskilled and unskilled workers.

In the plate-glass industry, the Glass, Ceramic, and Silica Sand Workers bargained with two groups. Here we have a typical situation wherein the large employers split off from the smaller employers and two different bargaining groups resulted. The two main companies, Libby-Owens-Ford and the Pittsburgh Plate Glass Company, bargain together, while the rest of the industry is organized in what is known as the Independent Fourcault Window Glass Manufacturers Association.

The coal industry began industry-wide bargaining in the anthracite regions, extended it then to the northern bituminous, and finally the southern bituminous regions, setting up three distinct groups which, however, for all practical purposes are controlled as one, owing to the immense power of the coal miners' union.

The railroad crafts have bargained for many years on a national basis. As a matter of fact, because of the national emergency character of the crafts involved and of the disputes arising therefrom, Federal legislation has provided for their special handling.

The Wallpaper Institute has a long history of industry-wide bargaining with the United Wallpaper Crafts of America, as does the National Automatic Sprinkler Association with the United Association of Journeymen, Plumbers and Steamfitters.

The Stove Manufacturers Protective Association, bargaining with the Molders Union of North America, is another case; as is the Wire Cloth Manufacturers of America bargaining with the American Wire Weavers Protective Association.

The National Elevator Manufacturing industry which bargains with the International Union of Elevator Constructors is still another example.

For ten years the Full-Fashioned Hosiery Manufacturers of America negotiated with the American Federation of Hosiery Workers, AF of L, before changing over to the Textile Workers Union of America. This is a classic example of how "stability" is brought to an industry. This industry has a permanent impartial chairman for the administration of the contract. I should like to point out, however, that after many years of experience the bargaining practice of this union recently has been modified. Local wage scales are being negotiated in areas within and under the framework of a general agreement.

The Northern Silk Mills, the Northern Cotton Mills, and of recent years the Southern Cotton Mills, have entered into other long-term textile industry-wide contracts.

The needle trades present perhaps the most interesting example of a completely organized industry where there is such close co-operation between employers and union that it has frequently been said the greatest problem in the industry is turnover of employers and not of employees. The stabilizing influence in the industry is the union, which provides technical help, research, management techniques, and frequently financial aid to employers. This industry is composed of men's and women's clothing, millinery, and the fur industries for the most part.

The contracts are administered by a multiplicity of impartial chairmen, numerous joint boards and stabilization commissions. The union and employers are very active in going after "run-away shops." These are the employers who leave unionized areas and set up in a hinterland because they can open up a shop with little capital and do a seasonal business with a quick profit. Another relationship which is carefully watched by both the union and employers is the jobber-contract relationship, since the seasonal fluctuations of the industry frequently produce an oversupply of "fly-by-night" contractors who take a quick profit and depart, often without paying their employees. For years, however, the needle-trade unions have attempted to stabilize the several parts of their industry outside of the New York metropolitan area, but have not been successful except in the men's clothing industry.

Another example of industry-wide bargaining which, however, begins to take on the character of areas or regions, is the Paper and Pulp Industry of the Pacific Northwest. This industry deals with the International Brotherhood of Papermakers and the Pulp, Sulphite and Paper Mill Workers.

The fishing industry is also on an association basis.

The National Association of Retail Meat Dealers has dealt

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with the Amalgamated Meat Cutters and Butchermen of North America for years. This contract covers some 30,000 dealers, mostly in the Midwest. An interesting departure is that this association recognizes wage differentials in the several cities and carries on its wage-rate negotiations with separate associations in the various cities under the terms of a general agreement covering the basic phases of the union-management relationship.

Another example of area associations is that of the twelve interstate trucking associations which now deal with the International Brotherhood of Teamsters.

In 1947, the Bureau of Labor Statistics in the "Monthly Labor Review" made an extensive analysis of industries covered by industry-wide agreements and found the following percentages of workers under such status.

Clothing—men's and women's; coal; laundry, cleaning and dyeing; longshoring; maritime; shipbuilding and boat building	80–100 per cent
Baking; book and job printing; canning and preserving; construction; dyeing and textile finishing; glass and glassware; malt liquors; pottery; trucking and warehousing	60–80 per cent
Building service and maintenance; leather products; newspaper and periodicals	40–60 per cent
Beverages (nonalcoholic); hosiery; hotels and restaurants; jewelry and silversmiths; lumber; shoes	20–40 per cent

TREND TOWARD GEOGRAPHIC BARGAINING

I should like to point out that a cross-study made at the same time of national industry contracts versus regional, metropolitan, city and county contracts showed that those industries which I have cited as having a long history of national or industry-wide bargaining still remain on the basis of national or industry-wide bargaining; whereas in recent years, as new industries have become organized and "stabilized," the tendency has been toward establishing bargaining on a geographic basis—regional, metropolitan, city and county. Table 1 indicates this trend.

TABLE 1 INDUSTRIES PARTICIPATING IN GEOGRAPHIC BARGAINING

National or industry	Geographic (regional)	City-county-metropolitan
Coal	Canning	Baking
Elevator installations	Dyeing and finishing textiles	Beverages (nonalcoholic)
Glass and glassware	Fishing	Book and job printing
Installation of automatic sprinklers	Hosiery	Building service and maintenance
Pottery	Leather	Clothing — men's and women's
Stoves	Longshoring	Confectionery
Wallpaper	Lumber	Construction
	Maritime	Cotton textiles
	Metal mining	Dairy products
	Nonferrous metals and products	Furniture
	Paper and pulp	Hotels and restaurants
	Shoes	Jewelry and silverware
		Knit goods
		Laundry, cleaning, and dyeing
		Leather products
		Malt liquors
		Meat packing
		Newspaper printing and publishing
		Paper products (except wallpaper)
		Silk and rayon textiles
		Steel products (except stoves)
		Tobacco
		Trucking and warehousing

It is estimated that there are now about 6000 associations in metropolitan, city, county, and local areas which bargain with unions, and these are principally in the field of construction, brewing, baking, retail trades, restaurants, trucking, barber shops, printing, etc.

EVOLUTION OF BARGAINING PROCESSES

Industry-wide bargaining and area-wide bargaining are evolutionary processes. They do not spring suddenly into being. The process is something like this. A union will succeed in organizing a company in the industry. It will add another company. Gradually, little by little, it will seek to organize the bulk of the employers in an industry. In the first stages, the union concentrates upon recognition. The next step in the union's plan is to obtain union security. In the past this stage has taken many years to accomplish. It has been accelerated by the opportunity presented the unions for holding elections on union shop prior to negotiations. The unions, having been successful in 99 out of 100 cases, thereby present employers with a rather high psychological hurdle to get over in negotiations, especially as relating to union security.

As each company is organized and a contract drafted, certain definite patterns common to the industry begin to form. Little by little, contract clauses under the guidance of astute union attorneys begin to evolve. This is the process of stabilization. Gradually the union is enabled to lighten its contract-administration load by resolving similar problems by similar contract clauses.

The "step ladder" then begins to evolve. For example, the union may succeed in securing from one or more of the larger companies in the industry certain nonwage benefits with respect to holiday, vacations, seniority rights or incentive pay. This then forms a "pattern" which the union attempts to impose upon the smaller companies. Quite frequently it works the other way around. The smaller companies or medium-sized companies are "step-laddered" into making concessions as a result of weakness at the bargaining table, and these concessions in turn are used by the union in negotiating with larger companies. The same is true with respect to wage increases, base pay, minimum starting pay, hiring rates, and the like.

In its drive to get uniform contracts—and stabilization—the union begins to quote as reasons for an employer's granting its demands that similar conditions exist elsewhere in the industry.

The next stage in stabilization—and one close to the time when a demand will be made for industry-wide bargaining—arises out of the operation of the contract through the grievance procedure, through the establishment of uniform arbitration clauses, and finally through the selection of one arbitrator who by reason of his experience and knowledge of similar problems becomes the adjudicator of disputes which arise throughout the industry. Since disputes often arise over contract interpretation of similar clauses, decisions become uniform, and a pattern develops. As this happens, industry becomes that much more stabilized.

GROUPING OF EMPLOYERS FOR BARGAINING PURPOSES

At this juncture, a portion of the industry, usually the larger companies, begins to recognize its weakness in bargaining as single companies, as against the well-organized union negotiating team backed up by well-staffed research departments. Employers then begin to think about bargaining in

groups. Frequently bargaining will be very informal, with the representatives from several companies sitting down, exchanging information, and interposing a united front in negotiation. If these employers are in the same area and subject to area employment conditions and similar rates of pay, this tendency to draw together for self-protection is greater. Along about this time the smaller companies begin to feel the impact of the unified bargaining of the larger companies. If they are grouped in the same area, for reasons of self-protection, they seek admittance to the group. If they are grouped in other areas, the union frequently forms another cell in its stabilization unit.

Often the smaller employers are marginal. If they are forced to sign the same wage agreements and give the same benefits as the larger companies, they may be forced out of business, frequently to be absorbed by the larger companies.

The unions, however, being made up of realistic men, take the situation as they find it. You may find contracts that are characterized as A, B, and C—each having the same clauses but establishing different scales. In this way the union seeks to keep its members employed and yet, recognizing the problem of the smaller employers, sets up scales of pay which are within their means.

The impact of industry-wide bargaining is not sudden. As I have indicated, it is a slow, creeping, evolutionary process. "Creeping paralysis" is the term which some employers use as a substitute for the union term "stabilization." Each year each company is gradually brought up to the terms of the most favorable contract in the industry. There is no particular problem in the early years of industry-wide bargaining in fitting the contract, which has been negotiated on a single-company basis, into the growing industry-wide concept, because it takes from 3 to 5 years of evolution from the single company to the group before a master agreement is developed. This allows time for the assimilation of additional costs in reaching the leveling-off state.

An industry-wide contract tends to lessen the day-to-day grievance load. This results from a relationship with the union of many years, mutual understanding of similar problems, similar handling of situations, and greater knowledge of wage rates, earnings, working conditions, etc.

MULTIPLE-EMPLOYER ASSOCIATIONS

Turning for a moment from the industry-wide bargaining pattern, I should like to discuss the multiple-employer association. The San Francisco Employers Council is typical. Literally hundreds of firms of diversified character are represented by the San Francisco Employers Council in contracts with Harry Bridges' dominant Local 6 of the Longshoremen's Union. The evolutionary process is at work in the multiple-employer association, too.

In multiple-employer bargaining units, a dominant union in an area and the employers in that area seek each other out for mutual protection. From the standpoint of the employers, it helps offset the economic advantage resulting from the union's power to negotiate with individual plants or establishments. From the standpoint of the union, it is well recognized that a new union has difficulty in organizing in an area which is covered by an employers' association, since it, as a new union, must undertake the laborious process of organizing one company, plant, or establishment at a time. This protects the dominant union from raiding.

In 1946 the Retail Merchants of Oakland and Berkeley Counties, California, with thirty affiliated stores, discouraged a new union from organizing stores in that area. In New York, in 1937, thirty-three employers in the wholesale dry goods field went on "strike" against their employees because the union had refused to recognize the employers' association—certainly a different twist to the situation.

The union has good reasons for desiring industry-wide bargaining and, for that matter, multiple-employer bargaining. It affords protection against raiding by rival unions. It also provides a history of a unit which is defensible before the National Labor Relations Board in contested unit cases. Ease of administration and negotiation by the union is another potent reason, since many unions do not have extensive administrative or negotiating staffs. The protection of the union as an institution, giving security to the professional union organizers, is a prime motivating force. The securing of increased wage rates and other benefits, contract by contract, by bringing all companies up to the highest paying company under contract, and by obtaining the most beneficial terms contained in any individual contract, is another union advantage.

Last but not least, the intelligent self-interests of the professional union organizer require that attention be given to the preservation and expansion of the union as an institution—"build the union" separate and apart from the membership needs. The master agreement is a defense against shifts in membership. It gives institutional security. Employers' associations with authority to bind members to the terms of an agreement are a virtual guarantee of such institutional security.

ADVANTAGES TO EMPLOYERS

There are advantages for the employers, too, in industry-wide bargaining or in multiple-employer association bargaining. The first of these is equalization of bargaining power. Employers standing together have strength and therefore a better bargaining position. Simplification of labor relations for an individual company is another advantage claimed by employers. Unions tend to become more responsible as they become more secure as institutions and help to enforce the terms of the current collective-bargaining agreement. This is particularly true if the international leadership is sufficiently strong to influence local groups. Where the international leadership is not strong enough and local groups carry the balance of power, industry-wide bargaining falls apart.

Uniformity of interpretation of the contract, standardization of job descriptions, job evaluations and terminology within the industry are advantages. The industry becomes better informed on the facts of the industry and, therefore, is able to present a stronger front at the negotiating table. The feeling of strength and security arising from the ability to take concerted action is also believed to be an advantage to employers.

STRIKES ARE FEWER

There are fewer strikes in industry-wide bargaining or multiple-employer unit bargaining. It is to be noted, however, that while there are fewer strikes, the strikes that do arise are of greater intensity, of greater length, and result in about the same loss of man-hours of production. Some employers who are very active in industry-wide or association-wide bargaining claim that there is a development of a community of employer interests as against the lone wolf tactics of many individual employers. I should say, however, that the most important practical advantage lies in the fact that a group of employers, via concerted effort, will be able to take a strike at the same time and, therefore, be assured that no business will be lost to competitors. However, the interdependency of American industry frequently shortens such industry-wide strikes. The development of mediation and conciliation techniques by the

several states, cities, and the Federal authorities also tends to shorten these strikes. Both the employer and the union recognize another very important point. If they can resolve their own difficulties, they will increase their chances of survival against the growing tendency for governmental intervention.

UNFAVORABLE ASPECTS

There are some very unfavorable results of multiple-employer bargaining or industry-wide bargaining—especially in the beginning. The early years usually provide a field day for the union. The initial advantages are theirs, which they will exploit to the fullest before the industry learns to plan, think, and work together in labor relations.

On the other hand, a weak union seeking strength through industry-wide bargaining will many times gladly give concessions which might be characterized as "Greeks bearing gifts." There may be more strikes in the early days because of the difficulty of reconciling many conflicting viewpoints between individual company managements. In the beginning one of the most difficult problems is the resolving of differences arising from the application of the several somewhat different clauses in the several contracts which relate to any one subject.

INFLUENCE OF GOVERNMENT

The Government has had considerable influence on the development of industry-wide bargaining. Cyrus S. Ching, when Director of Industrial and Public Relations for U. S. Rubber Company, pointed it out. E. H. Van Delden, Director of Industrial Relations for Libby-Owens-Ford, in a very excellent paper before the American Management Association, spelled it out as follows:

(*a*) The Government via the War Labor Board during wartime established commissions, arbitrators, and referees on a national and area industry basis.

(*b*) The National Labor Relations Board, by its decisions, determined that multiple-unit bargaining and industry-wide bargaining conditions provided a basis for sound collective bargaining units.

(*c*) The Fair Labor Standards Act and the Walsh-Healy Act have established industry-wide minima for wages.

(*d*) The OPA established price adjustments on an industry-wide basis.

(*e*) The War Production Board rationed materials on an industry-wide basis.

(*f*) The War Man-Power Commission and the Selective Service developed man-power controls and administered the draft on an industry-wide basis.

The rapid growth of industry-wide bargaining since the war is dramatic proof of the existence of such influences.

BASIC CONSIDERATIONS

Ours is a competitive system of enterprise. Labor seeks to be protected from the forces of competition, while the system as a whole is competitive. Standardization of wages, which is the expressed goal of the unions in industry-wide bargaining, upsets the traditional area wage patterns. Area and geographical wage differentials will be wiped out if the unions' objective prevails. Also, unions seek to bargain for all persons in an industry without the necessity of organizing all companies or plants and even without representation. It has a profound effect upon the employment market area by area. It discourages the normal flow of capital from the high to the low areas, and conversely the flow of labor from the low to the high areas. All of us can remember when the Ford Motor Company offered $5 a day as a minimum wage, and the resultant influx of thousands of workers from all parts of the country.

Decentralization and the pioneering expansion in new areas is the lifeblood of our economy. The application of rigid wage patterns throughout an industry stops such decentralization. The unions are fully aware of this. For example, in the 1930's the rubber industry began to migrate from Akron. In 1937 the union levied moneys for the alleged purpose of organizing the hinterland—$2\frac{1}{2}$ cents from each member; in 1945, 5 cents. Actually, the objective was not the organization of the hinterland but an endeavor to secure a return of the rubber industry to Akron. In recent years we have "Operation Dixie" by the Textile Workers Union of America, which is currently seeking 4 cents per man for this purpose.

HEALTHY RATE OF NEW BUSINESS

Another important consideration for a healthy economy is a healthy rate of new business. New business frequently starts with small capital. It must pay wages on the basis of the prevailing rate in the community. Industry-wide bargaining tends to accelerate the death rate of small employers and to have a deterrent effect on the birth rate. It promotes monopoly in the hands of well-established businesses, which tends to consolidate and merge these smaller companies. Marginal producers are eliminated and competition is stifled.

The next step in the process is the fact that ever-increasing labor costs, based upon stabilization and alleged ability to pay, are passed on to the consumer in price increases. A company and an industry adjust to the wage, rather than the wage adjusting to the company or the situation in which the industry finds itself. The traditional influence of the labor market has but little effect on price. Supply and demand adjust to price rather than price to supply and demand. This produces inflexibility, thwarts the operation of the economic laws produced by our system of private enterprise and free economy, and inevitably results in consumer exploitation.

Monopoly tends to develop because we have two great monopoly forces at work—larger and larger companies meeting larger and larger unions. This produces a state of monopoly capitalism which is a way-station to socialism. To the degree that monopoly forces attempt to work against the public interest, the Government in time will be forced to act. Coordination of wage demands in the several areas which upsets the traditional local area labor markets will, I believe, in time be declared against the public interest, since by this device labor is in effect creating a monopoly position which is the same as though competitive plants in an industry were to agree upon a common price policy. Collusive price fixing is contrary to public policy and is a violation of the antitrust law. The influence of powerful unions tends to fix costs and, by exerting such influence, tends to fix prices in the same manner. If industry-wide bargaining continues, with a powerful union on one hand and a powerful employers' association on the other hand—one stabilizing wages and the other stabilizing prices—two forces will merge in an attack on the consumer which is contrary to public interest. A grave question is raised as to what the public interest is under the impact of these forces, and this in time will lead to governmental intervention.

I believe that unions and employers are beginning to recognize the necessity for bargaining for wages and cost benefits in the local areas. The great growth of these area bargaining groups seems to indicate that collective bargaining must be and is being carried on with due consideration and restraint in the light of the local employment markets and local wage characteristics.

1949 ECPD ANNUAL REPORT

Chairman Summarizes Activities During the Year

By J. W. PARKER

CHAIRMAN, ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

THE records of the Executive Committee of the Engineers' Council for Professional Development and of its standing and special committees justify the conclusion that definite progress is being made toward the Council's objectives. While the purposes of the various committees and of the Council itself have been repeatedly described in the Charter and from time to time in the annual reports of Council, it is well that they be continually restated in order that members of the engineering profession, as well as those actively engaged in the work of the Council, be reminded that the whole activity is directed toward the development of the engineering profession, and of an awareness of the responsibilities which are laid upon its members. The reports of the standing and special committees indicate that all of them are continually re-examining their programs with these objectives in mind, selecting the lines on which it is clear that immediate advancement can be made. The full reports[1] of the committees are commended to the officers and members of every engineering society and of the eight supporting societies, of course, in particular. A careful reading of them will amply repay the reader.

STUDENT SELECTION AND GUIDANCE

In the field of student selection and guidance, the Council has established on a self-supporting basis its activity in aptitude and achievement testing known as the Pre-Engineering Inventory. When it developed that the cost of the service was proving greater than estimated when the arrangement with the Engineering Testing Service was entered into, a special committee of ECPD, consisting of Dr. H. S. Rogers and Dr. Allan R. Cullimore, conferred with Mr. Henry Chauncey, president of ETS, with the result that a new arrangement has been made providing that the Pre-Engineering Inventory will be supplied to teaching institutions on a rental plan, in either short or long form, to be scored by the institution or by ETS at the using institution's option. The short form of test is intended principally for admissions testing; the long form for guidance purposes. A graduated scale of prices has been established for varying types and amounts of service performed by ETS. With scoring by the institution, the rental of the short-form test materials will be at the rate of $1 per examinee. The cost to the teaching institutions will be considerably less burdensome than under the first arrangement with ETS.

The so-called "national testing program," offering tests to all individuals applying for them and conducted at well-distributed testing centers throughout the country, is being amalgamated with the more widely available College Entrance Examination Board tests. They are administered, as formerly, at the expense of the individuals tested. These tests will be conducted in over 300 examination centers. A new Board examination has been prepared for 1949–1950 which includes certain additional tests in order that the complete test battery will be very closely the equivalent of that of the pre-engineering inventory.

The Committee on Student Selection and Guidance plans to issue a new guidance booklet for the use both of guidance counselors on the staffs of secondary schools throughout the country, and of the volunteer counselors who take part in guidance conferences held in various large industrial centers. The Committee is aware of the need for systematic instruction of engineering counselors everywhere and is planning to initiate a program to that end.

In the secondary schools of smaller communities, student counseling by engineers in active practice is not now available, and the Committee is considering the possibility of establishing such a service wherever possible.

ENGINEERING SCHOOLS

The Committee on Engineering Schools believes that the whole field of accrediting needs thoughtful co-ordination not only with regard to the accreditation of undergraduate college curricula but also as to the inspection and accrediting of technical institutes and as to postgraduate study whenever that is undertaken. They have in hand the establishment of minimum standards of engineering content in curricula to be inspected and passed upon by the delegatory regional committees and are engaged, furthermore, in a re-examination of questionnaires addressed to the institutions to be inspected.

The Council has before it the recommendation of the chairman of the Subcommittee on Technical Institutes, Dean H. P. Hammond, that this subcommittee be made one of the standing committees of ECPD. It has been urged by several members of the present Council, on the other hand, that the original designation of the main committee as one dealing with engineering schools was with the express intent of co-ordinating all of the Council's work in the accrediting field through a single committee.

Whether or not the charter of ECPD should be amended to provide for this and possibly one other standing committee recommended by the special Committee on Principles of Engineering Ethics, will be the subject of discussion at this annual meeting of the Council.[2]

A subcommittee under the chairmanship of Dean S. S. Steinberg is continuing to give attention to the possibility of assisting the engineering colleges of South America in the establishment of a program of accrediting based upon instructional standards which will be essentially uniform with those adopted in this country.

Meantime the Committee reports substantial progress in its two-year postwar program of initial inspections and of reinspection of curricula dealt with in the earlier years of the program.

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[1] Complete reports of ECPD Committees will be available shortly in the Seventeenth Annual Report for the year ending Sept. 30, 1949, of Engineers' Council for Professional Development, 25–33 West 39th St., New York 18, N. Y.

Presented at the Seventeenth Annual Meeting, Chicago, Ill., Oct. 28–29, 1949, of the Engineers' Council for Professional Development.

[2] At Chicago ECPD voted to refer this question to the Executive Committee for study and recommendation.—EDITOR.

PROFESSIONAL TRAINING

The Committee on Professional Training has been actively engaged in establishing a seven-point program directed toward extension of educational processes by systematic means into the period following graduation from engineering college. In the coming year they will promote the implementation of this program of activity in the local sections of national engineering societies, expecting that at community level participation will be had from a number of societies other than the eight directly sponsoring the national organization of ECPD.

The plan envisages an organized program for continuing an engineer's education into and through the years of active employment. In furtherance of the program, the Committee is making a survey of the availability of courses of graduate study in urban areas and is arranging for a series of papers discussing, among other subjects, the status of licensing, and the most effective training programs carried on by employing industries. The Committee will place emphasis on extending aid to engineering graduates preparing for registration and, above everything, upon the continuation of the engineer's formal training during employment in industry. Particular attention will be given to industry's contributions in this field and to continual self-appraisal by the individual himself of his past accomplishment and of his prospects for future growth.

PROFESSIONAL RECOGNITION

In the year just concluded ECPD has approved the report of its Committee on Professional Recognition recommending the adoption of uniform nomenclature in designating the several grades of membership in the constituent societies and the establishment of minimum standards for admission to the respective grades. In the application of these standards it should be noted that licensing of engineers by State Boards of Engineering Examiners is recognized and provision made for its evaluation. Before adoption by ECPD, these recommendations were thoroughly discussed in two conferences at which the constituent societies were represented by delegates chosen as particularly qualified to speak authoritatively for their respective societies.[3]

There remains the task of obtaining concerted action on this recommendation by the six supporting societies to which it is applicable and its later adoption by other qualified engineering societies through the effect of persuasion inherent in the establishment of any valid standard of this character.

PRINCIPLES OF ENGINEERING ETHICS

The Canons of Ethics for Engineers have been adopted by five of the eight sponsoring societies of ECPD, and have been incorporated in the constitutions and by-laws of several of these. Two others of the supporting societies have endorsed the Canons, while one has thus far taken no action in this respect.

In the meantime, however, fifty-six other engineering societies have by formal action adopted the Canons, in many cases having effected constitutional amendments for that purpose. Such an endorsement on the part of organizations having an unduplicated membership of over 100,000 engineers indicates unmistakably the need for a body of principles such as this, established as an ideal of conduct which all members of the engineering profession may recognize. As the Committee on Principles of Engineering Ethics remarks, the adoption of the Canons by so many of the organized societies of the profession achieves one of the original concepts of ECPD and is becoming a factor of no mean importance in the development of a more complete unity of purpose in the profession.

The Council has as yet taken no action on a recommendation of the special committee on Principles of Engineering Ethics that there now be formed a standing committee to administer the Canons and their orderly amendment as occasion may arise, and to promote their adoption by still other engineering organizations. The question will be discussed at the forthcoming annual meeting, as mentioned in an earlier section of this report.[4]

COMMITTEE ON INFORMATION

Your Chairman desires to acknowledge the especially effective work of the Committee on Information in executing its assignment of preparing and distributing the Council's publications, and of publicizing current accomplishments.

The Committee has during the last twelve months brought out new editions of several of ECPD's guidance booklets, including Dr. Wickenden's "The Second Mile." With the generous assistance of Dr. L. Austin Wright, who was present when Dr. Wickenden gave the original address on which this essay was based, the Committee has restored much of the original text so that the present revised edition contains not merely the substance but a great deal of the wit and literary value of the original.

Dr. Wickenden's last work, "A Professional Guide for Junior Engineers," has now been printed in pamphlet form and is in process of distribution.

The administrative conduct of ECPD's publishing activity has been distinctly improved. Book reviews of some of ECPD's more important publications appear from time to time in the technical press as a result of the Committee's efforts. They have also in preparation an outline of a talk describing ECPD's purposes and accomplishments, intended to be used for reference by speakers having occasion to describe the work of ECPD before interested organizations.[5]

ADMINISTRATION

As indicated in the budget to be presented at this annual meeting, the expense of carrying on the work in the ensuing year at the present level of activity will be sufficiently provided for from properly applicable reserve funds and from present sources of income.

As the work of ECPD at community level gets under way, the work of administering the Council will undoubtedly become heavier. Others of the supporting societies, furthermore, may establish additional groups of delegates similar to that known as the ASME Consultative Group to ECPD, which has representation from seven specialized societies in the mechanical field. This group and others like it, if they are formed, can be of great assistance to the Council in informing members of the profession of ECPD's policies and purpose and in bringing to the Council the advice and good will of large numbers of engineers now very little aware of what the Council is accomplishing. This expanding work of the Council will presently require some increase in staff and hence a moderately increased financial support. The evident value of the work, in the writer's opin-

(Continued on page 1031)

[3] It is planned to publish the report of the ECPD Committee on Professional Recognition, which contains the proposed uniform membership grades and their minimum requirements, in a future number of MECHANICAL ENGINEERING.—EDITOR.

[4] At Chicago Engineers' Council for Professional Development voted to approve in principle the procedure for amendment of Canons of Ethics for Engineers, recommended by the Committee on Principles of Engineering Ethics, and to refer the recommendation to the Executive Committee.—EDITOR.

[5] This "talk," entitled "What is ECPD?" will be printed in the forthcoming 17th Annual Report of ECPD and is also available as a separate reprint. Copies may be obtained from Engineers' Council for Professional Development, 29 West 39th St., New York 18, N. Y.—EDITOR.

SEVENTEENTH ANNUAL MEETING OF ECPD

Significant Gathering Discusses Many Subjects

AT THE seventeenth annual meeting of Engineers' Council for Professional Development, held at the Edgewater Beach Hotel, Chicago, Ill., Oct. 28 and 29, 1949, Harry S. Rogers, president, The Polytechnic Institute of Brooklyn, was elected chairman to succeed James W. Parker, who completed three years of service in that office. Col. L. F. Grant, Queen's University and Royal Military College, Kingston, Ontario, Canada, was elected vice-chairman, C. E. Davies, secretary, The American Society of Mechanical Engineers, and William N. Carey, executive secretary, American Society of Civil Engineers, were elected secretary and assistant secretary, respectively.

APPOINTMENTS OF NEW COUNCIL MEMBERS

Engineers' Council for Professional Development is a conference organized to enhance the professional status of the engineer through the co-operative efforts of the following national organizations concerned with the professional, technical, educational, and legislative phases of engineers' lives: American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, The Engineering Institute of Canada, American Society for Engineering Education, American Institute of Chemical Engineers, and National Council of State Boards of Engineering Examiners.

Each of the foregoing societies has three representatives on the Council. Representatives are appointed for three-year terms, one appointment being made every year. Representatives appointed to serve for the next three years are: Van Tuyl Boughton (ASCE), Curtis A. Wilson (AIME), William F. Ryan (ASME), M. D. Hooven (AIEE), L. F. Grant (EIC), W. R. Woolrich (ASEE), and Webster N. Jones (AIChE). Appointment of a representative of NCSBEE is yet to be made.

EXECUTIVE AND STANDING COMMITTEES

To serve on the Executive Committee the following were elected: Van Tuyl Boughton, C. E. Lawall, James W. Parker, E. W. Davis, L. F. Grant, H. T. Heald, C. G. Kirkbride, and C. S. Crouse.

Members of the standing committees, on which each participating organization is represented, were appointed. Chairmen of these committees are: Z. G. Deutsch, Student Selection and Guidance; S. C. Hollister, Engineering Schools; A. C. Monteith, Professional Training; and R. H. Barclay, Professional Recognition.

SESSIONS OF THE COUNCIL

The program of an ECPD Annual Meeting consists of an executive session of the Council, one or more general sessions to which visitors are invited, and social events.

At the executive session action is taken on the accreditation of curricula in engineering schools and technical institutes on recommendation of the Committee on Engineering Schools and its Subcommittee on Technical Institute Programs. Curricula accredited at Chicago will be added to the ECPD List of Accredited Undergraduate Engineering Curricula or the List of Accredited Programs of Technical Institute Type published by ECPD in its Annual Report.

General sessions of the Council are devoted to routine business and to the presentation and discussion of reports of standing and special committees and of the representatives of the organizations participating in the Council. Inasmuch as the substance of these reports is found in the Report of the Chairman, which is published elsewhere in this issue (pages 1023–1024) no attempt will be made to summarize them here. All reports will be published in full and amended form in the Seventeenth Annual Report of ECPD which should be available shortly.

REPORTS OF COMMITTEES

In connection with the report of the Committee on Student Selection and Guidance, H. S. Rogers spoke briefly on the current status of the Educational Testing Service. Mention of this Service will be found in Mr. Parker's report (page 1023–1024) of this issue.

For the Committee on Engineering Schools, S. C. Hollister presented a statement "Differentiating Characteristics of an Engineering Curriculum." This statement is based on the thesis that "if accreditation is to be successful, curricula so accredited must contain such characteristics as may readily identify them as *engineering* curricula." It points out that throughout differences of characteristics noted between the engineer and the person in an adjoining field one finds *ability to design* as a significant and distinctive element." "Design" is used in a broad sense, as the statement, which includes a new definition of "engineer," attempts to make clear. Although the statement has been subject to the critical review of many persons, it was thought wise not to incorporate it in its present form as an appendix to the published list of Accredited Undergraduate Engineering Curricula. Dean Hollister is to prepare an introductory explanation to accompany the statement. These will be circulated by the Committee on Information for publication in the society journals. As soon as possible this document will be published in MECHANICAL ENGINEERING in an effort to obtain extensive comment on it.

Both the Committee on Student Selection and Guidance and the Committee on Professional Training described their objectives and current programs. The program of each committee includes preparation, publication, and distribution of manuals to aid all persons interested and involved in the task of advising prospective engineering-college students, in the one case, on the choice of a career in engineering and the essential characteristics of an engineer, and, in the other case, to assist graduate engineers, industry, and sections of engineering societies in the carrying on postcollege training and development and in avoiding the postcollege slump. It was brought out that in both cases the work of the committees must be carried out at the community level and must be expanded to include areas where such work has not been initiated because of the low density of industrial concentration. Several representatives of industry and engineering councils who were present on invitation discussed the problems raised by expansion of the committee's activities and promised support in their communities.

The report of the Committee on Professional Recognition was largely devoted to uniform grades of membership in engineering societies. Three grades are proposed: member, associate member (this corresponds to the present ASME junior member grade), and student member. Carefully phrased statements of minimum qualifications for each grade, which are the result of several conferences at which the phrasing was thoroughly discussed, are included in the report. Two "optional" grades, Fellow (honorary status), and affiliate are also proposed and described. The report was approved. Action, essentially simultaneous, by the participating societies to adopt the proposed uniform grades, was urged and the recommendations of the Committee are being forwarded to the societies with this end in view.

The Committee on Principles of Engineering Ethics reported wide acceptance and adoption of the Canons of Ethics for Engineers by engineering societies but noted that they had not yet been adopted by three ECPD participating societies. A proposed procedure for the amendment of the Canons of Ethics, presented by the Committee, was approved in principle and referred to the Executive Committee for final approval.

Requests from the Committee on Principles of Engineering Ethics and the Subcommittee on Technical Institutes that their status be advanced to that of "standing committee" were referred to the Executive Committee for action.

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The report of the Committee on Professional Recognition was largely devoted to uniform grades of membership in engineering societies. Three grades are proposed: member, associate member (this corresponds to the present ASME junior member grade), and student member. Carefully phrased statements of minimum qualifications for each grade, which are the result of several conferences at which the phrasing was thoroughly discussed, are included in the report. Two "optional" grades, Fellow (honorary status), and affiliate are also proposed and described. The report was approved. Action, essentially simultaneous, by the participating societies to adopt the proposed uniform grades, was urged and the recommendations of the Committee are being forwarded to the societies with this end in view.

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The INTERRELATION *of* TECHNICAL EDUCATION *and* INDUSTRY

By T. KEITH GLENNAN

PRESIDENT, CASE INSTITUTE OF TECHNOLOGY, CLEVELAND, OHIO

THE American Society for Engineering Education during the past year has had as its theme "Partnership With Industry." This objective was discussed at the Society's meetings throughout the year and was the subject of articles in its official journal.

Such discussion may be taken as a commendable indication of the trend of thought among leaders in the engineering colleges, and I am convinced that we cannot be satisfied with any short-term use of this objective. Partnership with industry is fundamental to the work of the engineering school, not just for one year, but year after year. We must unremittingly sense its importance and give it a proper place in our thinking.

Now, a successful partnership obviously requires co-operation for attainment of mutual benefits and it is apparent to all of us that the engineering colleges and industry are already co-operating successfully in many ways. These relationships involve placement of graduates, research, consultant work, procurement of specialists for class and other lectures, prize competitions for students, financing of scholarships and fellowships, placement of faculty and students in summer jobs, "co-op" plans for the entire engineering course, inspection trips and, finally, direct financial contributions to education to provide buildings, equipment, and operating funds. You will note that industry plays an important role in nearly every one of these activities.

Although this is a considerable listing, it may well be that I have inadvertently failed to include other co-operative efforts which are equally as important as some of those mentioned. As an engineering-college administrator, I am concerned that education shall contribute its full share in these relationships. Our role must not be that of mendicants in academic cap and gown seeking industrial alms. Instead, in this partnership with industry, technological education must contribute its fair share—if possible, more than its share. Industry is entitled to a quid pro quo in this relationship and engineering education is capable of providing it.

It is true that in much of its co-operation with industry engineering education can offer only a contribution of intangibles—that evidence of the results from its efforts must be long deferred. We see such intangibles in the fundamental research of the technological campus which often must wait for the practical application that brings it to full fruition. We find them in the ever-better trained engineering graduate whose increased value to industry will become apparent only as the years of his service mount.

The feeling of urgency which I have in this matter of education making its proper contribution to the co-operative relationship does not come entirely from a sense of fair play and from gratitude for the help that industry is giving us.

Part of the motivation comes from the fact that it is to education's advantage to do everything it can to retain and increase industry's interest. So fundamental is industry's help to the success of our educational operation that we must spare no effort to stimulate the interest of the industrialist in working with us. This applies with special force to the privately endowed engineering colleges such as my own institution, Case Institute of Technology. With respect to financial support, the alternatives before the endowed colleges are clear: Either we must merit and obtain the support of industry, or we may be forced to turn to the government for assistance. If government aid is thrust upon us, our colleges may no longer be able to exercise to the full the independent leadership that has been the purpose of their being. While such control may not be inevitable, you and I would have little respect for an agency that provided funds and then did not want to know what was being done with those funds.

Engineering education therefore must do everything possible to improve existing relationships and seek new avenues of co-operation with industry. I wish to suggest to you three areas, none of which is wholly new to you, in which engineering education can and should provide co-operation of value to industry. You may, if you choose, characterize all of these areas as being concerned with intangibles. I make no apology for this. The nature of education is such that its major concern must be with intangibles. And it is my belief that, in facing the problems of our generation, education—yes, and particularly engineering education, if you will—must lay ever greater stress on those things that shape the attitudes, the beliefs, and the spirit of man.

ENGINEERING EDUCATION PROVIDES A CONTINUING STREAM OF TRAINED MAN POWER

One would not belittle the value to industry of results attained from research which it sponsors on college campuses, or of the consulting work done for it by engineering-college professors, but the fact remains that the greatest contribution education makes to industry is the continuing stream of trained man power that it provides. The future of American industry is being shaped in the classrooms and laboratories of today's engineering schools. The quality of the industrial know-how and leadership for the years ahead depends largely on what these colleges are doing for young men during the four or five or more years they spend on the campus. From industry's point of view, the man—the well-schooled engineer—is the most important contribution it receives from the college.

My first proposition is that engineering education can serve industry better—can co-operate more effectively—through in-

An address delivered at the General Luncheon, Erie, Pa., Sept. 30, 1949, at the 1949 Fall Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

creased efforts to give to industry the type of personnel it wants and needs. We are revising the specifications for our product to meet your demands more closely. In doing this, we need not be concerned with the technical requirements of industry. Technologically, we are meeting industry's requirements—our scientific and engineering training is sound, and we mean to keep it so by constant attention to the new trends in these ever-broadening field.

But we need a better understanding of industry's requirements in other fields. I am fully aware of the oft-repeated question, Why don't you teach them to write and to express themselves clearly in both oral and written form? I know that you are concerned about their interest in and understanding of human relations and some of the basic concepts of industrial organization. But there seem to me to be other and perhaps more important matters which can be discussed best with the top people in industry meeting with our deans and faculty members in frank discussions. What are we doing about—what is industry doing about—the underlying moral concepts on which this democracy was founded? Of what value is a course in business law or corporation finance if we cannot agree on the fact that the law of an eye for an eye and a tooth for a tooth is not conducive to productive co-operative human effort. I am encouraged greatly by the signs that appear more frequently these days of the recognition by management of the essentially responsible position that industry must play in our society as a whole. Can we not work together to determine ways and means of inculcating these concepts in the minds of students and providing a favorable climate for the maturing process as the boy steps into an industrial job?

To a greater extent than at present we can make use of the services of industrialists in the classroom. Normally, such visiting lecturers get a better hearing from the students than does the faculty member. The undergraduate believes that the information brought by the visitor is, so to speak, "straight from the feed bag" and he accepts it as realistic and practical, whereas he may be inclined to view the advice of the faculty member as being, to a degree at least, theoretical. I'm not suggesting more speeches praising the so-called free-enterprise system. An objective appraisal of the value of sound ethical practices in everyday operations, well illustrated by examples from personal experience, will have more lasting effect than most management talks about the importance of considering the foreman as a part of management. A simple but thorough explanation of the composition of the stockholding group in almost any corporation will tell more of the essentially democratic character of the capitalistic system than can result from the indirect approach of a high-powered lecture on the evils of communism. A positive approach is always better than a negative one.

OVEREMPHASIS ON SECURITY

As an example of the matters of attitude with which we must deal in readying the student for an industrial career, let us note current patterns of thought on "security." A recent article in *Fortune* magazine describes an alarming trend in the emphasis on economic security which now seems to be the chief objective of a substantial portion of our youth of college age. The *Fortune* article does not stand alone in pointing out this tendency. Evidence of this trend toward overemphasis of security comes from many sources. Personnel officers of large corporations find in their recruitment of college graduates that it is far too frequently the deciding factor in choice of employment.

The trend is deplorable but understandable. The young men and women who are being graduated now have lived their impressionable years in a period of depression, extreme governmental paternalism, devastating war, and now an uncertain peace. Small wonder that it has become more the rule than the exception for the present graduate to seek security.

This overemphasis of security on the part of the younger generation is deplorable not only because it imposes unfortunate restrictions in the selection of careers, but because it constitutes a rotten spot in our social and economic thinking as a nation. We can realize the danger that lies in placing such high values on material security when we consider that it has been this bait that has most readily drawn nations into the traps of the dictators, past and present. Correcting the thinking of students with respect to security is a service that higher education owes not only to the individual student but to the nation. We can use the help of industry in this task.

HELPING THE ENGINEERING GRADUATE IN INDUSTRY

The second method through which I believe engineering education can expand the scope of its co-operation with industry is that of taking a continuing interest in the graduate after he has left the campus. In this, I am suggesting that we take a page from industry's book. The smallest of industrial concerns takes great pains to be sure that its product functions in a satisfactory manner. It follows that product into the buyer's shop or home and services it to assure that it gives the greatest possible value. How many engineering colleges have followed this desirable practice with respect to the human product graduated from our institutions? Here and there the need for postgraduate guidance has been recognized and groping efforts have been made to deal with the problem, but to date little has been achieved.

How, then, can we go about this task of postgraduate guidance effectively? The logical initial step would seem to be that of fact finding. We might start with a personalized review of the progress of our last ten classes of graduates. In doing so we shall wish to learn more than what positions the alumnus has held and what salary level he has attained. We shall wish to know why he thinks his advance has been rapid or too slow. What has he done to help himself? What kind of encouragement did he find provided by his employer? We shall wish to know what part he has taken in community life, what his attitudes are toward his job, what professional or business societies he has joined, and what education he has pursued since his graduation. Such a survey will make available valuable material for the consideration of engineering faculties and industrial organizations as well. It will produce information that will enable us to determine what steps in postgraduate guidance may be taken with the greatest expectation of profit.

This follow-up of the graduate engineer as he moves into his career is an effort in which further co-operation of industry is necessary. We need to know to what extent it has thought through and crystallized its objective in providing encouragement to the young man for whom it has paid a premium in terms of dollars. Recently in Cleveland we at Case asked the top-ranking executives of approximately 35 industrial concerns to meet with a number of our faculty and staff to discuss problems attendant to proper assimilation of the young graduate into industry. As the evening progressed, it became apparent that this matter had not received the careful and continuing attention of industry and of faculty members. Not only was there a lack of agreement on the value of industrial-training programs, but the existing courses indicated wide variety of approach. Nor is this condition with respect to the younger employees peculiar to Cleveland. I have seen neither an area nor a national survey bearing on this matter that has not indicated the same divergence of practices and large areas of indifference to the problem. No single way of handling it will serve satisfactorily for all employers, but there is evident need for study and action in this area. Integration of the newcomer

into the job is a riddle largely unsolved to date either by the employer or by engineering education.

The process is an educational one in which the colleges have the know-how required. Industry can co-operate with the engineering colleges further in this matter of postgraduate guidance through giving greater encouragement to its more promising young men to undertake formal graduate work in their fields of specialization in addition to the orientation courses now offered. We must not let the graduate engineer develop further the belief that the completion of the four or five-year college course is the end of his education. If he is to achieve his full potential of usefulness to industry, he must continue to grow intellectually.

ENGINEERING GRADUATE MUST BE TAUGHT AMERICAN CONCEPT OF DEMOCRACY

The third area of further co-operation which I wish to propose is one that will seem far afield for the engineering college which conceives its task to be that of technological education alone. American industry has taken the leadership and has provided the shock troops in the current struggle against foreign ideologies—in the battle for continuance of the free American system of individual liberty. Engineering education must co-operate actively by giving it aid, comfort, and well-trained recruits in this crusade. I believe that all higher education owes such a co-operative service to industry, but the obligation rests with special weight upon the engineering college. Not only will most of its graduates go into the service of industry, but with the present trend to move the engineer from the laboratory and the shop into the offices of industrial management, many a graduate engineer will need to be prepared to become a commander in the warfare of social, economic, and political concepts.

We have faced that problem at Case Institute and we are staking much on the answer at which we have arrived. We believe that the engineering student must be taught the American concept of democracy just as thoroughly and carefully as he is taught calculus. To do this, we revised our curriculum during the past year. We put into the freshman year a two-semester course on the "Background of American Democracy." In this course the faculty of our Division of Social and Humanistic Studies will co-operate to bring to the student from history, from economics, from sociology, from psychology, from political science, and from literature what he needs to know to understand the American system and to compare it with other systems. In the sophomore and junior years this faculty will provide the student a further background for understanding democracy by means of a continuous two-year course in "The Rise of Western Civilization." We have not accomplished this change through use of new course names. Five new faculty members have been appointed to handle the new courses and more will be added next year. If these courses can achieve the end for which they are designed, we shall consider the time devoted to them to be well spent in the engineer's education. Perhaps this activity will be a further and positive answer to some of the situations discussed in my first proposal.

The three additional areas of co-operation with industry which I have suggested have had little direct concern with technology. They deal with the all important matters of attitude and self-reliance; a real follow-up on the graduate in an attempt to appraise the quality and effectiveness of our education and provide further encouragement to the young graduate; and finally, a concern for the development of an understanding of our system of individual liberty and equal opportunity for all men. They have been directed to problems of educating the whole man, shaping his attitudes and his spirit. It is in these things that we are weakest and most troubled. In technology, engineering education is strong. We can say with confidence that America can and will solve its problems of technology and of dollars and cents. Whether America will solve its problems of the spirit is the question yet to be answered.

On this note I wish to join in a hope expressed by John L. Collyer, president of the B. F. Goodrich Company, in an address last year at Cornell University. Said Mr. Collyer:

"I believe that you share my hope that in the years to come generations now unborn will read and hear how after the Second World War, when the freedoms all men cherish were endangered, a remarkable endeavor gathered momentum in the United States of America.

"It seems—perhaps they will recall—that after devoting a century to an almost miraculous conquest of nature, the American people with unerring wisdom resolved that they would learn all that education could teach them about the institutions and ideals which make it possible to *foster* and *preserve* freedom In this way they received an understanding which equipped them to fulfill their individual and team responsibilities in citizenship.

"To those who will come after us this will seem to have been the kindling for a new light for mankind, for, passed from mind to mind throughout the world, this understanding of the roots of freedom will bring light again to peoples over whom darkness had already fallen."

Safe Handling of Radioisotopes

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possible. A suggested limit for contamination of surfaces, for example, is 0.1 mr per hr or equivalent, although the limit is somewhat flexible and dependent upon the circumstances.

Laboratories using radioisotopes should formulate rules governing surveys for radioactive contamination. The frequency of surveys depends upon the techniques used and the type and quantity of radioisotopes, and the nature of the manipulative procedures. It is a good policy to perform a thorough survey each week.

Floors usually constitute the greatest area of flat surfaces to be examined for possible contamination, and the survey is accomplished with ease if the instrument is mounted on a push cart as shown in Fig. 15. Each square foot of a floor can be covered in a relatively short time and with a reasonable degree of completeness.

Shoes are generally furnished to personnel employed in laboratories using medium and high levels of activity. The toe and the back of each shoe are painted (for example, a bright yellow) to distinguish them from the worker's personal articles. Such a device prevents the spread of contamination from the laboratory to the home or to other places since the paint serves as a reminder to change shoes before leaving the laboratory.

CONCLUSION

Radioisotopes can be handled without undue danger to the user provided the precautions necessary are understood and employed. Neglect of these requirements can, under certain circumstances, lead to serious, although usually nonpermanent type of injury. Because the levels of activity employed in the average laboratory or plants are in the microcurie or millicurie range, relatively simple precautions will suffice.

The enviable safety record which has been achieved in Commission installations is all the more impressive when it is compared to other industries using potentially destructive forces. One could not expect to number on the fingers of one

hand the people who have been accidentally killed by dynamite explosions, or by failure of boilers, or by electrocution, or who have been injured in mine accidents.

It has been repeatedly shown in the Commission installations that the degree of security afforded by proper safety control can be made such that 98 per cent of the workers receive less than one fifth of the permissible weekly dose and that the other 2 per cent of the workers seldom exceed the permissible dose in any one week.

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Isotopes as Tools of Engineering

(*Continued from page 990*)

This brief review has also pointed out some of the advantages of radioisotope utilization but has not touched on their limitations. At this stage of their utilization radioisotopes must be considered primarily as research tools and not necessarily applicable to all research or engineering problems. Radioisotopes, for instance, have not to date been widely used as tracers in process-control problems. For plant problems it would generally be necessary to use higher levels of radioactivity, and this would add the problem of radiation protection to other problems of industrial hygiene. Also in most instances it would be necessary to devise methods either for eliminating the activity from the finished market product or storing the finished product until the activity had decayed to a safe level. Much development work on these problems has yet to be carried out.

WHEN TO USE THIS METHOD

Unfortunately, there is no general answer as to whether the radioisotope technique will prove useful in the solution of a particular type of problem. Each problem must be considered individually and the merits of the radioisotope technique weighed against the advantages of other methods of analysis The radioisotope technique should only be used if there is no other way of solving the problem, or if it appreciably simplifies the job or guarantees better precision or sensitivity of measurement.

The limitations do not, however, detract from the over-all value of radioisotopes. They have already been established as having greater sensitivity, specificity, and versatility than any other research and engineering tool now known. Ample proof of their usefulness is evidenced by their increasing application to laboratory and plant problems. As more engineers become familiar with handling and using them, it is expected that industry will put them to greater and greater use As pointed out in the Industrial Advisory Committee's Report, "it is not unlikely that in time to come their use in automatic control of chemical, metallurgical and other processes will prove to be one of the most significant industrial values to come out of atomic energy."

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ion, will be sufficiently convincing to make the finding of additional financial contributions a not impossible task. It is a satisfaction to report that The International Nickel Company has repeated its contribution of $300 in support of ECPD. The gift was quite unsolicited and is therefore significant as an indication of potential financial support from other industrial organizations.

In concluding his three-year term of service, your Chairman wishes to remark that the growth of such a movement as that in which ECPD is engaged is in the nature of things of rather slow development. Men of great attainment worked devotedly for nearly ten years to write the Canons of Ethics for Engineers in the form now obtaining such broad acceptance. It will be so with others of the Council's important purposes. It will undoubtedly take some time to achieve them, but your Chairman looks forward to a time not many years from now when the work of this Council will be soundly established in industrial communities throughout the country, and when the Engineers' Council for Professional Development itself will be recognized as a national institution which will have made and will continue to make great contributions to the mental and spiritual health of the nation.

ASME PUBLICATION PLAN

A Report by ASME Publications Committee on First Full Year of Its Operation

AT THE 1949 Regional Delegates Conference, held in connection with the 1949 ASME Semi-Annual Meeting, San Francisco, Calif., June 27–July 1, 1949, it was requested "that the Publications Committee publish in the current year a review of the present publication plan outlining the general policies, costs, problems, and other pertinent information that will adequately inform the membership."

This report is an attempt to meet this request.

HISTORICAL DEVELOPMENT

One of the first acts of the Founders was to establish Transactions containing full texts of ASME papers and news of the Society affairs. Until 1927, when Transactions was established on a periodical basis and annual volumes were placed on a subscription basis, this Society publication appeared as an annual bound volume and was distributed free to all members.

In 1906 the Society expanded its publications by establishing a Proceedings, a monthly magazine carrying Society news and accounts of engineering progress. To make its name conform more realistically with its contents, Proceedings became the *Journal* in 1909, and eventually MECHANICAL ENGINEERING in 1919. Although some technical papers still appear in MECHANICAL ENGINEERING, the recent trend has been: (1) To include principally those of interest to a large number of readers; and (2) to expand the departments of the magazine that are devoted to summaries and abstracts.

MEMBERSHIP NEEDS FOR PUBLICATIONS

Membership needs for publications include: (1) News of the Society and the membership; (2) summaries of engineering development; and (3) details of engineering developments in the form of technical papers.

(1) *ASME News.* With regard to news of its own activities the Society has always had a virtual monopoly and a corresponding obligation for disseminating this news to the profession. This obligation is met by the ASME News Section of MECHANICAL ENGINEERING.

(2) *Engineering Developments.* In 1880 when the Society was founded, engineering literature was scarce and publication of important engineering data was largely the function of the professional-engineering societies. During the last several decades this situation has shifted drastically. Today the amount of mechanical-engineering literature published by professional societies, commercial publishing houses, and educational, governmental, industrial, and other research institutions is so tremendous that publications issued by ASME have become only a small part of the literature available to engineers. This growth has given rise to a need for digests of current literature. It is out of the question for each engineer to keep up with current literature by subscribing to all journals and by reading all papers. It is possible, however, for an editorial service to summarize the literature in digest form. Such a service is now provided in MECHANICAL ENGINEERING, in so far as ASME technical papers are concerned, by the new department, "ASME Technical Digest."

(3) *Technical Papers.* The growth of engineering publications has changed also the role of the Society as a source of and outlet for technical information. Because of the amount and diversity of current engineering literature, the Society can at best publish only a small portion of it. Because of the increased number of publications, an author is no longer compelled to look upon the Society as the principal outlet for the papers he writes.

Acceptance by the Society has long been considered the highest distinction that can be conferred on a paper in the field of mechanical engineering. Transactions and the *Journal of Applied Mechanics*, even on a subscription basis, have to be subsidized. Hence Society funds should be reserved for publication of papers of high quality. In view of the expense involved and the many opportunities for publication elsewhere, the Society should not accept papers of questionable significance.

For the papers that are issued by it, the Society should: (1) Provide bound copies (Transactions) for reference libraries, principally; and (2) provide separate copies of these and other papers for members who want them. While distribution of the bound Transactions has been well handled, procedures for distributing copies of individual papers need to be improved. These procedures are being studied, and as experience develops they are being improved.

THE PRESENT PUBLICATION PLAN

Briefly, the objectives of the present publication plan are: (1) To reduce waste and the net cost of publication services; (2) to improve the quality of papers published by the Society; (3) to bring all ASME papers to the attention of members; and (4) to make these papers available as quickly as possible.

To achieve these ends, the plan: (1) Placed Transactions and *Journal of Applied Mechanics* on a subscription basis, thus reducing waste and net cost to the Society; (2) instituted a new digest service in MECHANICAL ENGINEERING known as "ASME Technical Digest," thus bringing all papers quickly to the notice of members; and (3) established an expanded preprint service, thus making it possible to reserve Transactions for high-quality papers of permanent reference value.

The plan was based on the assumption that the relatively few members who use the specialized publications of the Society, Transactions and *Journal of Applied Mechanics*, should contribute something to their support. In 1947 the plan was approved by an 8-to-1 vote in one of the largest letter ballots in the history of the Society and was put into effect on Jan. 1, 1948, by order of the Council.

COST EXPERIENCE

Three factors are involved in an analysis of cost experience of the new plan: (1) The effect of limited distribution on production costs of Transactions and *Journal of Applied Mechanics;* (2) the effect of member subscription on income; and (3) the

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Approved by the ASME Board on Technology, Oct. 13, 1949. The ASME Publications Committee consists of J. M. Juran *chairman*, R. B. Smith, John Haydock, C. B. Campbell, and G. R. Rich.

effect of greater sales volume and higher administrative costs on the over-all cost of the preprint service.

Production Costs. Production of Transactions and *Journal of Applied Mechanics* for the first year (Sept. 30, 1948, to Sept. 30, 1949), the first full fiscal year of the plan, cost the Society $34,000, not including editorial, staff, and office expenses. If these publications had been distributed free to members of the Society as under the old plan, the cost would have been approximately $78,000. In production costs alone the new plan has effected a saving of approximately $44,000.

Income. Under the old plan the Society had some income from Transactions and *Journal of Applied Mechanics*, mainly from sales of bound volumes and subscriptions to nonmembers. The new plan introduced a new factor of income—that of member subscriptions. In 1948–1949 the over-all income from this source was $7000 in excess of that of 1946–1947, the last full fiscal year under the old plan. Most of this increase may be credited to the new plan.

Preprint System. Because of the greater number of preprints handled under the new plan, publication-sales expense naturally increased. However, income from sale of preprints during 1948–1949 was sufficient to meet the expense of this expanded service.

READING HABITS

While the apparent saving under the new publication plan was noted with satisfaction, the Publications Committee was disturbed by two questions: How much does the saving in production expense represent loss of service, or convenience, or both, to members? Who are the members who are subscribing?

To find the answer to the first question, the Committee found it necessary to answer the second. An analysis showed that of the 2000 subscribers only 600 were members, and also that 2.8 per cent of the junior members and 5.4 per cent of the members registered in other membership classifications were subscribers.

In June, 1949, letters were sent to 500 nonsubscribing members selected at random, covering three points: (1) Whether papers currently published in Transactions and the *Journal* were meeting professional needs; (2) whether in case of discontinuance of these publications, digests and the preprint service would be sufficient; and (3) personal reasons for not subscribing.

More than 225 of those polled replied to this letter, and three out of four amplified their answers by commenting on use or nonuse of the publications. From this information, the Committee drafted an answer to its first question.

It was discovered that limited distribution of Transactions and the *Journal of Applied Mechanics* had apparently caused little or no loss of actual service and only slight inconvenience to most members. Many members who use these publications in their work reported that they found it unnecessary to subscribe because access to ASME publications was provided by company, institutional, or local libraries. Some in this group suggested that they would prefer personal copies, but this service was not worth the cost of subscription. Members who were not habitual readers, generally men in supervision and production, reported that they did not subscribe because the subjects in which they were primarily interested were seldom covered in the archive-type papers published in Transactions. Papers of interest to many of these men are printed in MECHANICAL ENGINEERING in full or in digest form rather than in the Transactions, and hence the needs are met by MECHANICAL ENGINEERING and occasional purchases of preprints. The replies also turned up cases of members whose needs were not met because the Society meetings do not include papers relating to their particular field of interest. Meetings are the sole source of Transactions papers.

THE PREPRINT SYSTEM

When the new publication plan was conceived, preprint procedure was also changed. Under the scheme, an effort is made to provide preprints of every manuscript received in time for reproduction in advance of the meeting at which it is to be presented. Digests of these preprints are published in MECHANICAL ENGINEERING as soon as possible. The preprints are offered for sale at 25 cents per copy. Coupon books have been made available at the rate of 10 coupons for $2 to avoid the inconvenience to members of sending small amounts of money through the mails and to avoid individual billing of small amounts which is always an expensive accounting procedure. Free distribution of preprints at national-meeting session rooms has been abandoned.

Precedents for the abandonment of free distribution of preprints exist in ASME. For years at conferences of the Oil and Gas Power Division, and more recently at other division conferences, preprints have been obtainable only by payment of a registration fee. At ASME national meetings, a member formerly received a free copy of a paper under discussion at a session attended by him. If he ordered a preprint by mail or procured one otherwise than at the session where the paper was being presented, he was charged for it. There appeared to be an injustice in giving a preprint to a member who was able to listen to presentation and discussion of a paper, and to require a member who could not attend the session to purchase a copy. Free distribution of preprints to all members on request would have placed a heavy financial burden on the Society, and hence it was decided to abandon free distribution at national meetings.

With the appearance in MECHANICAL ENGINEERING of digests of preprints, a means has been established whereby every member of the Society, not only those attending meetings, is notified of the availability of an ASME paper and afforded an opportunity to purchase one. At present 73 per cent of all national-meeting papers are available in preprint form. The remainder are either received too late for preprinting or are luncheon addresses or other types of papers for which no preprint need exists. Many of these papers are published in MECHANICAL ENGINEERING after the meeting.

Although the preprint feature of the new publication plan appears at first sight to be sound and simple, it has required the greatest degree of change in administrative procedures and has given rise to numerous justified complaints. These complaints and many other facets of the preprint problem are being given intensive study.

Some faults have been corrected, and others will be corrected as soon as solutions can be worked out. This will be a major task of the Publications Committee during the coming year.

CONCLUSIONS

From its review of first-year experience with the new publication plan and study of results of this experience, the Committee has arrived at four conclusions:

(1) The publication plan now in effect is basically sound but can be improved in detail.

(2) The Society should continue publication of Transactions and the *Journal of Applied Mechanics*.

(3) Operation of the preprint service should be made more convenient for members.

(4) MECHANICAL ENGINEERING, which is the only Society publication received by all members, should be further developed as a comprehensive general-interest magazine covering the field represented by its name.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Physical-Science Internships

EXCELLENT opportunities now exist for outstanding students in science and engineering to broaden their undergraduate or graduate training through vacation-time employment and graduate fellowships offered by the National Bureau of Standards, according to Wallace R. Brode, associate director of NBS. The Bureau has established an integrated work-study program, beginning at the college-sophomore level, for the selection and training of its research scientists and engineers. This program permits the student to alternate periods of full-time study with actual work experience in his chosen field, supplemented by on-the-job training and orientation courses at the Bureau. At the same time it enables the Bureau to select promising students, upon graduation, for permanent appointment to its staff and to provide them with opportunities for professional growth and advancement through further in-service training.

As the principal agency of the Federal Government for fundamental research in physics, mathematics, chemistry, and engineering, the National Bureau of Standards carries on a wide variety of projects ranging all the way from measurement of the magnetic moment of the proton to the development of new types of materials for prefabricated housing. Work in these fields at the Bureau includes basic and applied research, development, testing, calibration, and scientific advisory services. This diversity of activity permits the student to choose work in his particular field of interest and to broaden his experience through contact with other related lines of work at the Bureau.

There are essentially three programs of interest to college and university students: The internship program for undergraduates, the regular training program for college graduates on the staff, and the fellowship program for graduates engaged in working for advanced degrees. Information regarding qualifications for appointment may be obtained from the Personnel Division, National Bureau of Standards, Washington 25, D. C.

Atomic Energy Vs. Coal

ATOMIC fuel will not become a significant competitor to coal for from fifteen to twenty-five years, and perhaps not for a much longer period, Philip Sporn, Fellow ASME, president of American Gas and Electric Company, told representatives of the nation's coal industry at the annual meeting of the National Coal Association in the Waldorf-Astoria Hotel, New York, N. Y.

"There appears to be every reason for belief that someday nuclear fuel will be burned in industry," Mr. Sporn declared "But how long will it take before that actually comes about?

"Responsible people are using estimates of the cost of a nuclear power plant which run all the way from $140 to $1000 per kw—a 7 to 1 range. I am not certain that even this range covers the outer limits on either the upper or the lower side We do not know the sensible limits; estimates must be largely guesswork because we lack the essential facts for accurate engineering judgment.

"Two unknown factors constitute the principal barrier to any sound engineering appraisal of the economics of nuclear fuel utilization: Lack of knowledge on many phases of reactor design, construction, and operation—which makes it impossible to estimate capital costs; and lack of knowledge and practicability of 'breeding' (producing more fissionable material than is consumed in the operation of the reactor)—which makes it impossible to estimate fuel costs.

"If someday the guess at the lower limit is realized or bettered, then atomic power will have great social and economic significance. Even if we can't get costs down to or near the lower limit, it can still have significance in places remote from economical sources of fuel or water power.

"If costs should stay near or above the very high guesses, then atomic power is unlikely to be used except for such applications as military craft, where cost can be disregarded."

Mr. Sporn pointed out that the Atomic Energy Commission reactor-development program involves, at present, four experimental reactors. None of them is intended to be capable of supplying power to drive an airplane or a ship, or the power to light a city.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

"The program is designed first to provide for research in relation to materials. At the same time it is designed to take the first steps toward producing a significant amount of electric power, although at what cost, no one can as yet foretell.

"It seems to me that with all the technical problems still to be solved, the first and purely experimental phase of the program will take from three to five years. Within from six to ten years from now we may have a reactor producing electric power. Ten to fifteen years hence we may have some commercial generation of nuclear power. But I anticipate it will then be commercial only in the sense that it will be operating more or less regularly, day in and day out."

Mr. Sporn did not anticipate that the recent announcement that Russia had produced "an atomic explosion" would greatly alter this timetable.

"If it results in a newly enlarged emphasis on the military aspects of atomic energy, it would doubtless lengthen these time intervals," he said. "But we have been assured that all emphasis desirable and perhaps possible has already been placed on the production of materials for atomic weapons.

"In the light of this, I would expect the Russian news to have no appreciable effect on the peacetime exploration program."

Discussing the problems of coal-industry developments in the face of atomic-energy prospects, Mr. Sporn further declared that even if the cost of a reactor for power purposes can be brought within practical economic limits and breeding can be developed, "the degree of competition will depend not only on how successful the nuclear-power program turns out—but also on how successfully the coal industry can meet the ever-present challenge of advancing its own technology and discharging its social-economic responsibility."

Citing the course taken by the electric-power industry, he added, "The possibility that nuclear reactors will become practical and economical devices has been reckoned with but has had no retarding effect on expansion plans based on the most modern technology possible today."

Home Management

CO-OPERATIVE thinking of many groups in our economy is now being directed to easing women's tasks in the home, Dr. Lillian M. Gilbreth, Fellow ASME, and president of Gilbreth, Inc., of Montclair, N. J., said recently at an ASME Metropolitan Section meeting.

To illustrate some of the factors in a problem of home management and how they are being attacked by groups other than engineers, Dr. Gilbreth cited the procedure of the New York Heart Association in setting up a Heart Kitchen.

The problem was to design and set up a demonstration kitchen for a homemaker with a heart condition that would demand as little energy from her as possible, and enable her to use what energy she has to the greatest advantage and with the most satisfaction, said Dr. Gilbreth.

The New York Heart Association set up a committee to advise on the project. This consisted of representatives of various branches of medicine, architecture, engineering, home economics, psychology, psychiatry, family relations, biomechanics, physical and occupational therapy. Fundamental principles were contributed; the kitchen-planning expert submitted a plan; this was criticized and modified; the kitchen was built and equipped, and opened to the public.

It had been agreed that the low-income family should be considered, which meant finding or making inexpensive available equipment and furnishings. Every energy-saving device, existing or imagined, was to be used. The result was supposed to interest the entire family involved and to give satisfaction not only by creating fine operating procedure but by being conducive to fine family relations.

Least expenditure of energy of the housewife implied the following:

1 Eliminating all human effort possible through use of gravity, magnetism, proper work heights, arrangement of equipment to minimize reaching, stretching, bending, pushing, pulling, lifting, and the like.

2 Utilizing other members of the family for taxing work that could not be eliminated.

The techniques were those used in work simplification, following the principles of motion study. The difficulties arose largely through lack of equipment designed to save energy, like the stove with a high oven. Low-cost equipment was largely unavailable and lacked adjustability. Weight of utensils was a problem. Lack of wheels or casters on tables, chairs, and other furniture involved energy expense. It was evident that manufacturers had not considered the amount of energy the use of their products involved. "Homemade" additions and gadgets brought surprising results.

The outcome was a kitchen that at least indicated how time and energy can be saved, and made homemakers with no health difficulties ask, "Must I have a heart condition to get a kitchen like that?"

Dr. Gilbreth said the engineer could look at this case as typical of what he faces in problems of management in the home. They call for all his knowledge and experience in other fields, she declared, plus interest, tact, adaptability, imagination, and co-operation. In attempting to solve these problems, she said, the engineer should insist not only that human relations be checked and be right before he starts his work, but should know enough about human relations to be an asset and not a liability as he works. She said he should always remember that these problems cannot be solved by engineers alone or by any group alone. They demand the co-operative thinking of every group in our economy, she said.

It is perhaps unnecessary to say that the home is not only important in itself, in that it is a dominating factor in our satisfaction with life but that it has an enormous effect on all the activities of our 24-hour day, 7-day week, said Dr. Gilbreth. It plays a great part in our education, our habits, our demands. It affects our participation in business and industry. It is increasingly being recognized as influencing our operating and personnel effectiveness. Realizing this, the engineer should assist in every way in the solution of home-management problems, and support the management groups who are working in this field, especially our National Management Council.

Low-Temperature Alloy

A NEW alloy steel said to be capable of subzero service at operating temperatures as low as —423 F has been developed by the Lebanon Steel Foundry, Lebanon, Pa.

An austenitic cast ferrous alloy containing 19.5 per cent chromium and 9 per cent nickel, among other alloying constituents, this alloy steel, identified as Lebanon Grade 22, may be applicable in the oil, chemical, and other processing industries. It already has been used effectively in the production of steel castings for pressure equipment in storage facilities for liquid oxygen used as a propellant for rocket engines. Such storage is maintained under high pressures at temperatures of approximately 298 deg below zero. Pending are other applications in various restricted ordnance fields.

The new alloy cast steel is reported to have shown no struc-

tural changes down to —423 F in hundreds of testing laboratory impact tests from production lots of (L)-22 castings, and the same cumulative tests have indicated appreciable increase in hardness directly proportional to the decrease in temperatures.

Another factor is that the tensile strength of the particular cast austenitic alloy varies inversely with temperature, and in direct relationship with hardness. Ductility is lowered somewhat, but not in proportion to the increase of tensile strength, which is estimated to be approximately 200,000 psi at —423 F, with retention of adequate strength factors and resistance to embrittlement.

The alloy is said to be easily welded by either gas or electric processes without need for subsequent heat-treatment, since low temperatures do not seriously impair the as-welded impact resistance.

This same alloy, paradoxically, also is being used at extremely high operating temperatures, such as in jet-engine components, turbosupercharger parts, and other gas-turbine uses.

Icosasphere

SPHERICAL tanks are economical for pressure storage because that shape most effectively resists internal pressure and because the area of shell per unit of volume is less than that of any other shape. The use of spherical tanks has been restricted because of the rather large amount of scrap or waste material involved in their construction from rectangular plates. Recently, however, a new method of designing and building welded spherical tanks and other double-curved plate surfaces, which has resulted in considerably reduced scrap loss and welding, has been announced by the Pittsburgh-Des Moines Steel Company of Pittsburgh, Pa., and is described in a research report by J. O. Jackson, vice-president of the company. The method is based on a new development for predicting the flow or displacement of materials in plates which are bent, formed, or drawn in such a manner that plastic flow occurs.

This manner of predicting plastic flow consists of forming the desired object of a suitable plastic material, softened by heat and allowed to cool between dies, or otherwise restrained to the desired shape. The edges of the piece are then trimmed to the outline required, after which the trimmed piece is relaxed by heating to the softening point when it will flatten and assume the outline of a properly shaped flat piece, which if dished

FIG. 1 PRESSED PIECES OF PLEXIGLAS FOR FORMING THE PLATES OF A SPHERICAL SHELL BEING CHECKED FOR ACCURACY

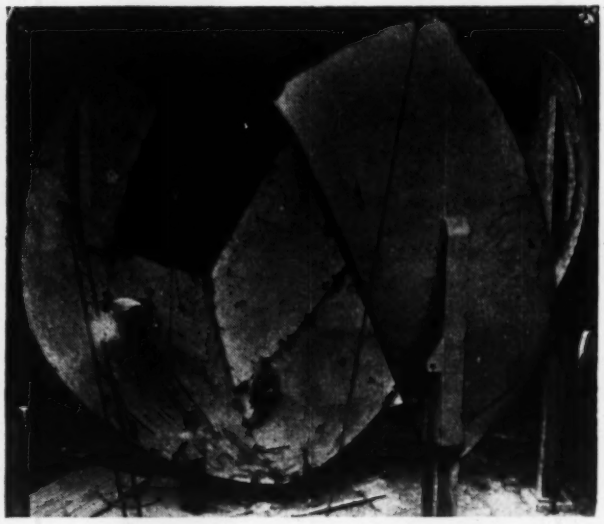

FIG. 3 ERECTION AND TACK WELDING OF THE ICOSASPHERE
(Note rectangular shape of plates.)

or formed to the proper shape, will flow plastically to produce a finished piece of the proper shape.

This process is applicable to any formed work where plastic flow is involved, as, for example, spherical tanks; wind-tunnel flares, nozzles, contraction pieces; hemispherical, elliptical, and toroidal tank bottoms; and in any other dished, pressed, drawn, or warped plate work.

The first application of this method was to determine the shape and arrangement of plates to form a spherical tank shell with a minimum amount of scrap loss and a minimum number of feet of welded seam. Spherical tanks have been made with several plate layouts. The most common layout is known as the "orange-peel" design and usually consists of a top and bottom saucer with one or more courses of approximately vertical plates in between. These vertical plates are wider near the center of the sphere and taper toward the top and bottom so that they resemble orange peels. Since these plates are tapered, two can be cut from one rectangular plate, which reduces the scrap. However, when this is done, the finished sphere plates are much narrower than the economical width which results in a considerable increase in the footage of welded seams over that resulting if only one sphere plate is cut from each rectangular plate. However, if plates of maximum width are cut singly to form the separate plates, the amount of scrap is excessive.

The cubical layout was developed some years ago in which rectangular plates were laid out on the sides of an imaginary rubber cube circumscribed by a sphere. The cube is then expanded until its faces touch the spherical shell. In expanding the cube to fit the sphere, all of the edges of the plates will become curved, but the plates will be more nearly rectangular in shape than the orange-peel plates and the amount of scrap will in most cases be reduced.

In the study made by the plastic-model method, several layouts were considered, were quickly made on the dished plastic, relaxed, and the shape of the relaxed plates measured to determine the best layout.

Any layout of plates for a sphere which is to have a repeating pattern must be based on the faces of one of the regular polyhedrons of which there are but five. These are the tetrahedron with four triangular faces; the hexahedron, or cube, with six square faces; the octahedron with eight triangular faces; the

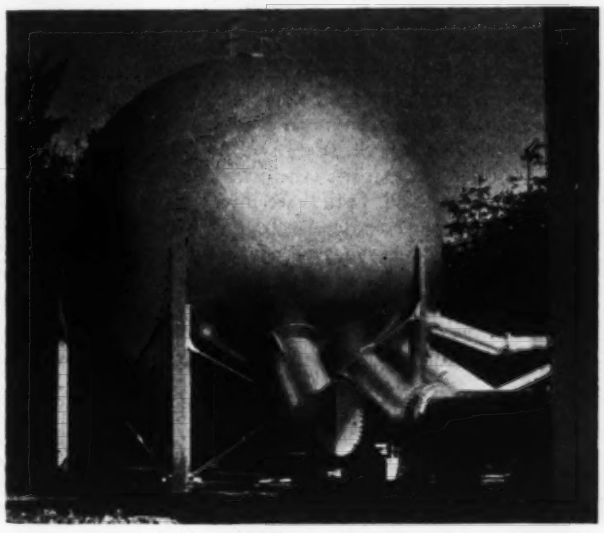

FIG. 3 COMPLETED ICOSASPHERE
(This sphere is 32 ft 5 in. inside diameter, 1/2 in. thick, and is made of only 20 shell plates. It is supported on 5 columns.)

dodecahedron with twelve pentagonal faces; and the icosahedron with twenty triangular faces. The icosahedron may be built without scrap loss for the triangles may be alternated and cut from a rectangular plate without any waste. Four adjacent faces of an icosahedron may be flattened and they will form a parallelogram. Five of these parallelograms will form the entire surface of an icosahedron. These facts suggested that if a spherical shell were formed by five parallelogrammic units, each of which represented four adjacent triangular faces of the icosahedron expanded to the spherical surface, the layout might be the best one possible from a standpoint of scrap loss. A sphere may be divided into twenty equilateral spherical triangles, but it is not possible to divide the surface of a sphere into more than twenty equilateral triangles for the same reason that it is not possible to have a polyhedron of more than twenty faces which are identical.

The Icosasphere is then a sphere laid out along the expanded lines of four adjacent faces of an icosahedron. Five plates cut to the proper shape, and dished, will form a complete sphere. These plates may be cut from one rectangular plate with a remarkably small scrap loss. As the size of the sphere increases, it is necessary to further subdivide the five parallelogrammic units, and designs have been prepared based on subdividing each side into two, three, four, and eight subdivisions. Table 1 shows the excess steel that is required to be purchased in square feet and in per cent of the area of the sphere, and also the number of feet of joints, usually welded joints, required for each layout and for three sphere diameters. If the cost per foot of joint is added to the cost of scrap for any assumed thickness for the various layouts, the most economical layout may be determined;

TABLE 1 COMPARISON OF REQUIRED MATERIAL AND FEET OF SEAM FOR DIFFERENT SPHERE LAYOUTS

Layout	No. of plates	Ordered excess[1] Sq ft	Ordered excess[1] Per cent	Ft of seam
10-Ft-diam spheres				
1 Icosasphere	5	57	18	83
2 Orange peel[2]	6	125	40	96
3 Cube layout	6	62	20	70
20-Ft-diam spheres				
4 Icosasphere	20	221	11	423
5 Orange peel[2]	12	670	34	362
6 Orange peel[3]	32	447	23	600
7 Cube layout	18	367	19	420
50-Ft-diam spheres				
8 Icosasphere	48	888	11	1418
9 Orange peel[2]	40	3460	44	1548
10 Orange peel[3]	50	1609	21	1903
11 Cube layout	30	1224	16	1279

[1] Ordered excess is area ordered less area of sphere expressed in sq ft and in per cent of sphere area.
[2] One sphere plate cut from one rectangular plate.
[3] Two sphere plates cut from one rectangular plate.

Fig. 2 shows the erection and tack welding of the plates forming an Icosasphere which was 32 feet 5 in. inside diameter, also, see frontispiece on page 984 of this issue.

The completed sphere shown in Fig. 3, was erected in a single day, but the welding of the seams took many days. After completion, the shell was tested to 100 psi hydraulic internal pressure which it withstood satisfactorily. The shell was designed for an external working pressure of one atmosphere, or 14.7 psi. The high internal pressure test of about 6.8 times the external working pressure of the sphere was for the purpose of removing flat spots and rounding out the surface of the sphere so that it would more effectively resist the external pressure.

The design and construction of the Icosasphere is covered by patent applications owned by the Pittsburgh-Des Moines Company.

U. S. Airliner Supremacy?

AMERICAN transport planes will soon lose the world-wide supremacy which they have possessed exclusively for so many years, Dr. John T. Rettaliata, Mem. ASME, dean of engineering, Illinois Institute of Technology, Chicago, Ill., declared at a recent meeting of the American Institute of Electrical Engineers, in Cincinnati, Ohio. He said, "With its new type gas-turbine and jet airliners Britain is winning its bid for universal air leadership (See "Gas-Turbine Airliners" on page 1039 of this issue). Many of our latest medium-range piston-engine commercial aircraft are already obsolete. In the civil aircraft field America is repeating the same mistake made in World War II in military aircraft, when we permitted the British to conduct the development work on jet engines while our facilities and engineering talent were used for the mass production of conventional piston engines. As a result we lagged behind the British in the jet-engine field, and spent several years in approaching their accomplishments. Even today we do not have jet engines with ratings as high as the British."

The British are working on two types of commercial transport planes, the turbojet and the turboprop.

The de Havilland Comet is the most notable example of British efforts in the field of turbojet transports (See MECHANICAL ENGINEERING, October, 1949, page 840). After further modifications to improve range, which is now about 2000 miles, it is intended to fly from London to New York in six hours. This is approximately half the time now required with conventional transports. Flight tests on the Comet have revealed it to exceed its cruising speed and altitude specifications. Fourteen Comets are on order for the British Overseas Airways Corporation, and two for the Ministry of Supply.

In addition to developing their own planes, the British have also upgraded a Douglas DC-3 by installation of two gas-turbine turboprop engines in place of its two piston engines, Dr. Rettaliata revealed. The 3000 DC-3's now in operation will become obsolete when the new international regulations requiring ability to take off on only one engine are put into effect. The turboprops will meet this requirement and offer a means of salvaging these planes. Furthermore, the converted DC-3's would be capable of increased speeds and pay loads up to ranges of approximately 350 miles.

He reported that Canada is also actively engaged in the construction of turbojet aircraft. The Avro XC-102 is the Canadian contribution to high-speed airliners. This 50-passenger jet transport has a normal range of approximately 500 miles cruising at 400 mph at an altitude of 30,000 ft. Performance tests to date have demonstrated the exceptional characteristics of the plane. Rumors indicate contemplated purchases by American operators.

Some of the advantages claimed for jet airliners are that for a given volume of traffic fewer planes are required due to their greater speed, consequently reducing investment. Because of the purely rotary motion of the turbojets compared with the reciprocation of piston engines, the jet airliner is virtually vibrationless, thus enhancing passenger comfort. Its cabin noise is also greatly reduced. It is reported that pilots in the XC-102 do not require earphones. As for maintenance, the Air Force states that only five man-hours are required for a complete change of turbojet engines compared with 150 man-hours for piston engines.

Dr. Rettaliata stated further that the United Kingdom readily recognizes and accepts the superiority of the jet airliner over the conventional piston-engine type. Such recognition is clearly evident by the intense British development program now under way. It is catastrophic that similar foresight is not prevalent in the United States. There is not a single turbojet or turboprop transport now under construction in this country, he said. Even if such construction were started today, it would still be at least three years before commercial operation could be realized. Undoubtedly progressive airlines in this country will be purchasing foreign jet transports in the interest of continuing the best type of service available.

He pointed out that from a technical and production standpoint the United States is better qualified to develop turbojet transports than any other country. It is unreasonable to expect, however, that private industry, even though convinced of the desirability, could undertake such a program without federal assistance. The British developments have been under government subsidy. It would appear logical to employ some military appropriations for such a purpose, as transports are certainly used to a large degree in the normal conduct of wartime operations. He urged that if the United States is ever to regain its eminent position in the transport field positive action should be taken, and soon.

Jet and Rocket Research

THE progress made in jet and rocket research at the Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics in Cleveland, Ohio, during the past year is reviewed in the October 15, 1949, issue of the *Technical Data Digest*. In describing the problems the organization is trying to overcome in developing new materials for use in supersonic aircraft power plants, it was emphasized that until such materials can be developed, or ways found to overcome the limitations of present materials, faster speeds and higher altitudes will remain in aviation's future.

With the accomplishment of short-duration supersonic flight speeds by full-scale research craft like the Bell X-1 and with the necessity of sustained supersonic flight speeds, NACA's research efforts are being intensified to solve the basic supersonic propulsion problem, i.e., how to obtain engine types capable of developing the extremely large powers required.

A subsonic airplane of about 50,000 lb capable of flight at 400 mph at 30,000 ft required engines developing 3000 hp. An airplane of the same weight reaching a speed of Mach 1.5 at 50,000 ft needs an engine providing 15,000 hp. And another 50,000-lb craft attaining Mach 2.5 at 70,000 ft would need about 45,000 hp.

The Lewis Laboratory now is carrying on investigations of turboram and ramjet engines because of their ability to handle large quantities of air relative to their size, and because their power increases with flight speed.

NACA's three laboratories (the others are at Langley Field, Va., and Moffett Field, Calif.) are investigating the compression problem at supersonic speeds, and although much improvement at all speeds has been achieved, research is continuing to bring actual compressions even closer to the theoretical maximums.

Research now is directed to evaluating the off-design characteristics of different supersonic inlets to determine how they influence the utility of engines of fixed design.

Another research task is determining the quantitative effects of pulsations on compression over a wide range of operating conditions.

Since 1945 the velocities at which good combustion efficiencies can be maintained have been tripled and NACA researchers expect even further progress. In the same way, progress has been made in increasing the altitude limits for satisfactory combustion. This has resulted from research on flame-holding devices, fuel-injection methods, and combustion chamber designs.

The point has been reached where supersonic propulsion systems can no longer be isolated for separate study; they must be investigated with the complete airplane configuration.

To conduct this work, the engine nacelle must be completely submerged in a supersonic air stream and, engineers said, reliable data can be obtained only with larger models. NACA scientists are using the free-flight technique to collect data on the transonic speed range. For the higher speeds, a new 8 × 6-ft supersonic wind tunnel, which has been in operation at the Lewis Laboratory for a few months, is used. This ultramodern tunnel is equipped with all the latest devices, including television, to study the effects of high speeds on winds, engines, and fuselages.

The NACA is continually attacking the problem of the use of critical materials in gas-turbine engines and rockets.

For example, a complete turbine wheel accounts for 30 per cent of the critical elements used in making a typical jet engine, and therefore is a focal point in the search to reduce the use of strategic materials. During the past year the systematic study of both ceramals and intermetallics using domestically available components has been carried on. One of the most promising is molybdenum disilicide but this combination has not yet been fully explored.

Another attack has resulted in reducing the amount of vital materials used in making turbine wheels. Considerable progress was made by the Lewis Laboratory in developing a design method to make sure that such wheels are stressed to their maximum limits.

Turbine cooling is also expected to result in increased power and economy and reliability of operation, as well as the conservation of strategic metals.

NACA now is investigating the use of hollow and internally finned hollow blades, and additional cooling by the use of air or water.

Scientists connected with NACA believe the principal improvements in gas-turbine engine performance will come from increasing the engine pressure ratio, as well as cooling the turbine. They, and other aeronautical scientists, are becoming increasingly aware that peak engine performance requires redesigning the engine for a particular application rather than seeking to use a single engine for a wide range of service requirements.

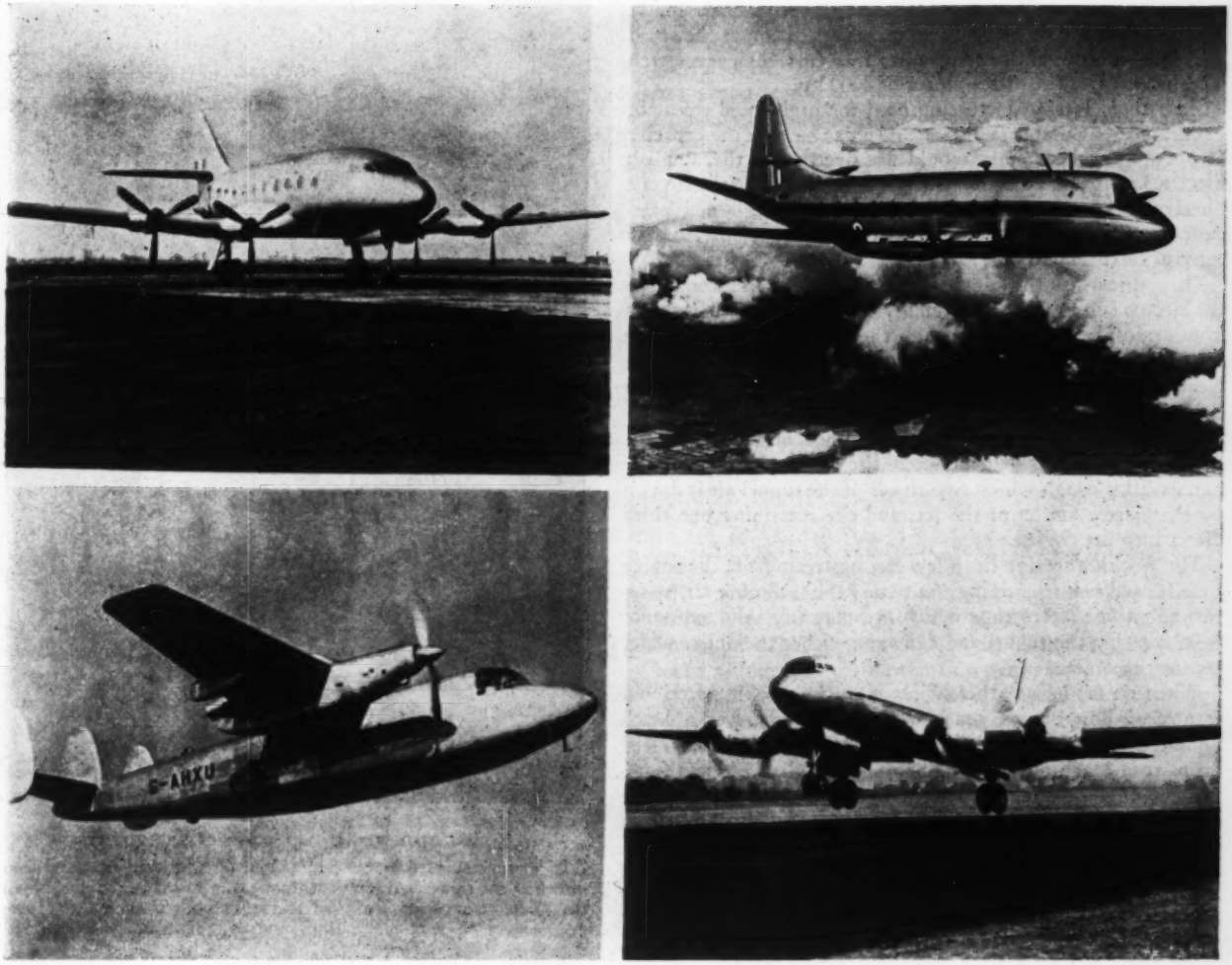

FIG. 4 BRITISH TURBOPROP AIRLINERS

(*Top left:* Armstrong Whitworth Apollo; *Bottom left:* Handley Page Mamba Marathon; *Top right:* Vickers Armstrong Viscount; *Bottom right:* Handley Page Hermes 5.)

Gas-Turbine Airliners

DEVELOPMENT of the gas-turbine aircraft engine has now reached a stage where the turboprop airliner is already becoming a commercial proposition. A compromise between the orthodox piston engine and the pure jet, the turboprop has been found to have certain advantages over both. The turboprop airliner is likely to be more economical since it secures the best fuel consumption at speeds approaching maximum; piston engines usually have to be run at about 50 per cent of maximum speed to obtain the best efficiency.

For example, the new Vickers Armstrong Viscount will have a cruising speed of 85 per cent power of 327 mph and the Handley Page Hermes 5 will cruise at 350 mph—only three miles per hour below its maximum speed.

Powered by four Armstrong Siddeley Mamba engines, the new Armstrong-Whitworth Apollo medium-range airliner will seat from 24 to 31 passengers and a crew of three. The Mamba gas-turbine engines each develop 1140 hp. The Handley Page Mamba Marathon feeder-service airliner has a cruising speed of 250 mph and a range of 770 miles. It will carry from 14 to 18 passengers or 4370 lb of freight. The Marathon is powered by two Armstrong-Siddeley Mamba engines developing over 2000 hp. Believed to be the world's largest and most powerful turboprop airliner, the 40-passenger Handley Page Hermes 5 is powered by four Bristol Theseus turboprop engines, each developing more than 2500 hp. The Vickers Armstrong Viscount turboprop airliner is powered by four Rolls Royce Dart engines, each developing 1420 hp. It will have a seating capacity of from 40 to 53 passengers.

Low-Cost Wind Tunnel

WIND tunnels have been in use by aeronautical engineers since the dawn of flight. From them came much of the information leading to faster and better airplanes. As flight speeds increased so did the demands upon the wind tunnel, and the size and cost of this essential instrument of research has tended to rise with the passing years.

Most of the wind tunnels used by private aircraft manufacturers are comparatively small and limited to test work at relative speeds well below those which are now becoming general in flight. The majority are built on the closed-circuit principle, in which air is constantly circulated in an endless tunnel by an electrically driven fan.

In Great Britain, the cost of building a high-speed wind tunnel of conventional design was too high for any individual

manufacturer to face, and the only tunnel capable of testing at high subsonic speeds—that is, at speeds approaching the speed of sound—was one built and operated by a Government research establishment. This has a motor of 4000 hp.

Since there was an increasing need for high-speed research, a shortage of available facilities, and a danger that the capacity of the government unit would be overtaxed, the English Electric Company, according to The Society of British Aircraft Constructors Ltd., conceived the idea of applying a new principle to wind-tunnel construction at a cost far below that of conventional tunnels.

They discarded the closed-circuit principle and turned to the ejector (or straight-through) system, in which air is taken from atmosphere, passed through the tunnel, and returned to atmosphere. To create the air flow they used a Rolls-Royce Nene, turbojet engine which has a static thrust of 5000 lb as an ejector pump.

The Nene is housed in a nacelle carried in a bulge in the tunnel. A space is left between the inner nacelle and the outer wall through which two thirds of the tunnel air is drawn by the ejector action of the jet, and the remaining one third direct into the engine.

The working section lies a few feet upstream from the engine nacelle, and before entering the tunnel the incoming air passes through a fine-screen cage which prevents any solid substance from entering the tunnel and damaging either the object under test or the engine.

When no model or other object is in the working section a rate of air flow of nine tenths the speed of sound or a Mach number of 0.9 is reached; with a test piece in position, the speed drops to a Mach number of 0.85. The English Electric Company is now working on a wind tunnel to give speeds above that of sound, using no more power than that available from a Nene engine.

As to duration, the tunnel could be run nonstop as long as the engine keeps going, without drawing upon any external source of power.

A straight-through tunnel of this type would suffer from condensation trouble on most days of the year if the humidity were not lowered at the intake. To prevent this trouble from developing, a part of the hot exhaust is collected and mixed with the incoming air. Although this adds moisture, the humidity is lowered by a rise in temperature.

Another advantage of this tunnel is its compactness. The first has been fitted into a wartime piston-engine test bed, measuring only 60 ft × 34 ft × 18 ft high. From this building extends a large-diameter 40-yd-long diffuser which carries away the ejected air.

The entire installation, including all the accessories and instruments that go with it, costs only a few thousand pounds.

Aluminum Welding

A PROCESS which is expected to revolutionize industrial and job welding of aluminum has been developed by the Air Reduction Sales Company in research conducted at its Murray Hill, N. J., laboratories and at Battelle Memorial Institute, Columbus, Ohio.

It is reported that with this new process aluminum plates 1/8 in. to 3 in. or more in thickness are readily joined. It is said to be at least four times faster than any previously known process of welding aluminum which produces welds of equal quality. It requires less skill than present methods of fusion welding of aluminum and is adaptable to semiautomatic and machine operation. No solid fluxes are required, there are no slags to be cleaned from weld joints, and the welder's work is not interrupted to change electrodes. It is claimed to be the only semiautomatic fusion-welding process known today with which aluminum welds can be made with ease and with little skill in any position—flat, horizontal, vertical, or overhead.

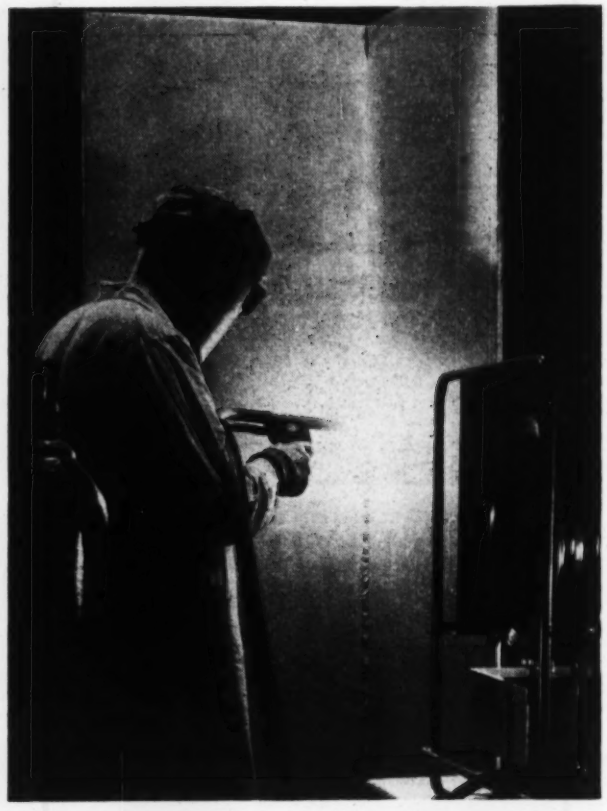

FIG. 5 WELDING ALUMINUM PLATE IN UPRIGHT POSITION
(The filler metal is fed to the welding gun automatically from the spool, shown at the right. Argon or helium gas, also fed to the gun, shields the molten aluminum from air and eliminates the need for fluxes, electrode coatings, and slag removal.)

The process, termed "Aircomatic," utilizes a pistol-shaped welding tool, through which bare or processed filler metal in wire form is fed at controllable rates of speed. The filler metal carries the welding current and an arc is maintained between the end of the wire and the work. A sheath of argon or helium gas surrounds the arc and prevents air from coming into contact with the molten metal. Power may be supplied from a standard welding generator. The equipment includes both semiautomatic gun and fully automatic equipment.

With the semiautomatic unit, all of the standard joint designs may be welded in every welding position. Pressure on the gun's trigger maintains a closed welding circuit and also a closed circuit in the wire-advancing mechanism. The shielding gas is impinged upon the work through a nozzle which surrounds the wire electrode.

Malleable Iron

TO reflect the fruits of 50 years of research and product improvement by the malleable iron industry, the Malleable Founders' Society has produced and recently previewed "This Moving World," a sound film in technicolor made by Roland Reed Productions, with narration by Edwin C. Hill.

The motion picture, although instructive, is active and interesting. One learns that "malleable iron is not ordinary iron but a special kind of iron" first made by Reaumur, a great French scientist and metallurgist in 1722, and initially produced in America, a century later, by Seth Boyden. It shows how, in this age of speed, malleable iron withstands shock and impact, meeting all demands made upon it.

From a material suited to use as parts of wagons and bicycles in the early nineteen hundreds, malleable casting properties have been improved to the point where they demonstrate their outstanding toughness and dependability in today's high-speed automobile, truck, and railroad transportation. Malleables now have yield points of 35,000 lb and tensile strengths of more than 50,000 psi, accompanied by elongations of 10 to 20 per cent depending upon the grade specified.

"This Moving World" depicts the molten metal as it courses through the molds, solidifying about sand cores to form the exact intricate design of the required casting. In an animation sequence, showing what takes place in the anneal, the carbon is seen to separate out into nodules embedded in the tough iron. Yet, it is pointed out, this metal may be easily and economically machined into finished parts for the automotive, railroad, agricultural implement, pipe-fitting, and many other industries.

The 30-minute technicolor and sound film will be available in 16-mm or 35-mm size to engineering and technical societies, students in engineering schools, customers of the industry, business groups, and others who may be interested, from James H. Lansing, Technical & Research Director, Malleable Founders' Society, 1800 Union Commerce Building, Cleveland 14, Ohio.

Titanium Powder Metallurgy

HOW titanium powder, from which the Bureau of Mines makes the new light, strong, durable, and corrosion-resistant metal titanium, is produced at the Boulder City, Nev., station is described in a recently released Bureau report. Pilot-plant production of the powder by the Kroll process has been going on at Boulder City since 1944 when it was transferred there from the Salt Lake City, Utah, station where the process was developed in 1942. Titanium technology had been under study since 1938 at the Bureau's Tucson, Ariz., station.

Although the element titanium has been known for more than 150 years, the report observes that only recently has the metal itself been available in a form pure enough to enable metallurgists to estimate its suitability for structural use. "Pure enough" means low enough in hydrogen, oxygen, and nitrogen, it is explained, because the presence of any of these gases embrittles the metal more than 10, or even 20 times as much as the metallic impurities likely to be present.

To produce ductile titanium by powder metallurgy, the method used by the Bureau, it is necessary to start with powder free from gaseous impurities. Although hydrogen, if present, can be removed completely enough for all practical purposes by heating the metal in a high vacuum, the report notes, no method of removing nitrogen or oxygen is yet known. To prevent contamination, therefore, the titanium tetrachloride from which the powder is produced is treated in equipment so designed that the titanium comes in contact only with iron and helium during production. After it has cooled to room temperature, exposure of titanium to air does no material harm.

Because for some time the Bureau was the sole producer of ductile titanium and the demand for this metal—as strong as mild steel, as corrosion-resistant as stainless steel, and about twice as light as steel—was great, the production technique at Boulder City was standardized. As the report is based upon 94 runs of 100 lbs of powder each, it includes considerable data on production costs.

The report describes the preparation of the raw materials used in producing titanium powder—liquid titanium tetrachloride, as already mentioned, and metallic magnesium. The reduction apparatus and its operation are described, as is the processing of chips removed from the reaction chamber when it is being cleaned after a run.

Operating data for 10 consecutive runs, believed to be typical, are given in detail. Experimental work on modifications of the standard process, which was carried on to a limited extent, is described, and the control of the quality and purity of the product is discussed.

A free copy of Report of Investigation 4519, "Production of Ductile Titanium at Boulder City, Nev.," may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh, Pa. It should be identified by number and title.

Absorbent Dehumidifier

A NEW system of air conditioning giving complete control of temperature and relative humidity, holding constant conditions, or varying them at the will of the user, has been developed by the Niagara Blower Company, New York, N. Y. It is said to provide dry air at normal atmospheric temperatures with little or no refrigeration required. A condition of 15 grains of moisture per pound of air at 85 F dry-bulb temperature is reported to have been produced without refrigeration.

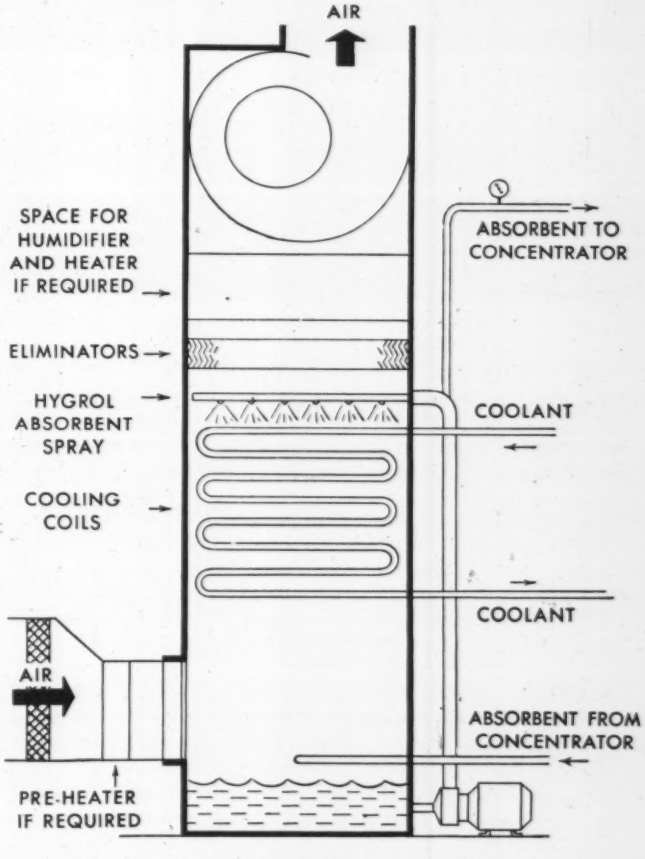

FIG. 6 FLOW DIAGRAM OF CONTROLLED-HUMIDITY METHOD

The apparatus is enclosed in a casing through which the air is drawn by fans. The air is filtered and then enters a chamber where it is dehumidified in passing through a spray of "Hygrol" liquid (a hygienic hygroscopic chemical that absorbs the air-borne moisture and contains no salts or solids to precipitate). In the same chamber are located cooling coils which remove the latent heat of evaporation and also do any sensible heat removal that may be needed. The air stream then passes through entrained moisture eliminators and is diffused in the space to be conditioned.

The absorbent liquid spray falls into a tank at the base, from which it is piped to a concentrator which removes the moisture taken from the air. The reconcentrated liquid returns to the system. This process is continuous, and the apparatus operates at full capacity at all times.

The same equipment may be used to provide winter air conditioning when required, by installing a tempering coil at the outdoor intake, a humidifier, and a reheat coil above the eliminators.

This equipment is manufactured in a range of sizes providing from 1000 to 20,000 cfm of conditioned air from a single unit, and multiple-unit installations are practical. It is expected that by reducing the need for refrigeration, the cost of air conditioning will be reduced by this method. Applications generally are in a temperature range from 35 F upward.

Installations, thus far, have been made in food and chemical-process industries, in packaging hygroscopic products, for preventing condensation of moisture on metals and other products in storage, in air conditioning for laboratory control, and for human comfort.

Instrumentation

PRESENT demands for instrumentation improvement are essentially twofold: higher sensitivity and faster response, writes Dr. E. U. Condon, director, National Bureau of Standards, Washington, D. C., in the Oct. 7, 1949, issue of *Science*. These are necessary, he says, because the time intervals with which present-day work is concerned are extremely small, only minute displacements may be allowed, and the signals are low in power. In general, sensitivity can be increased if the time during which phenomenon is under observation is increased, but this often cannot be done because the existence of the phenomenon may be of short duration—as in, for example, nuclear and cosmic physics and in the study of biological cells. At the same time, noise level becomes a serious limiting factor where signals are weak.

In spite of these incompatible objectives, instrumentation is succeeding in extending sensitivity and signal response, but in the process large quantities of complex data are the result, creating the problem of processing such information. Here other instruments, whose functions are the orderly and integrated presentation of data, are needed. Recording devices are typical of this class of instruments, but more sophisticated types are necessary now for the analysis of large amounts of data, the performance of predetermined operations, and the presentation of the summarized findings, discarding unwanted background. Fortunately, machines like electronic digital computers, originally planned for solving mathematical equations, afford a means of attaining this end. Specific problems to be considered in the program of the National Bureau of Standards include transducers, electron optical field mapping, data transmission and reduction, improved microscopes, and so on. Work on some of these is already in progress. Coincidentally, the bureau's program in electronic digital computers is continuing: two machines are under construction in its laboratories in Washington and Los Angeles, while another five are being built by contract with private laboratories and industries.

One aspect of instrumentation, Dr. Condon says, is the problem of materials and components. Related to this is the existence of principles of measurement whose application cannot be realized until developments in another field of science are achieved. Thus electron optical field mapping represents an application of principles in optics to electronics, yet the realization of this important research tool had to wait until the science of electronics had advanced to its present state. An illustration of the dependence of instruments on materials is the wire strain gage. The principle was known as long ago as Ohm's law. Yet it was not until Simmons, Ruge, and De Forest developed methods of bonding the wire to paper and ways had been found to measure and record small changes in current that the principle was applied successfully. It is for these reasons that the study of materials and components, as well as the study of past methods proposed for measurement problems, is an integral part of the Bureau's program.

The need for cross-channeling information in the sciences has grown acute in recent years. When it comes to instrumentation, this need has two aspects: basic developments in one field may provide the basis for instrumentation in another field and instruments developed in one field may have applications in others. As an illustration of the first aspect, scientists in the Bureau's radio propagation laboratory recently developed and constructed an atomic clock which has remarkable precision. The heart of the development is the application of the knowledge of resonance absorption in atomic physics and of microwave radiofrequencies to the problem of time. Again, the Bureau has developed a standard of length based on the green line of mercury 198. This development depended on knowledge of atomic and nuclear physics, while the realization of the instrument and associated apparatus is a combination of knowledge in electronics and optics. An analogous story could be told about the recent measurement at the Bureau of the magnetic moment of the proton. Here then, at least in part, with excellent possibilities for full development in the future, is the basis for atomic standards of the three basic measurements—time, length, and mass.

Gas-Turbine Operation

SUCCESSFUL operation with inlet gas temperatures of 1500 F has been accomplished in tests on the Allis-Chalmers 3500-hp gas-turbine plant at Annapolis, Md., the U. S. Navy and the Allis-Chalmers Manufacturing Company have revealed. This turbine unit is the first to be designed for long-time service with operating temperatures as high as 1500 F, according to Allis-Chalmers engineers. (See "3500-Hp Gas-Turbine Plant," MECHANICAL ENGINEERING, June, 1946, pages 571–574).

Installed at the U. S. Naval Engineering Experiment Station in 1944, the elements of this gas-turbine unit have since been operated in more than 3000 turbine-hours of rigorous testing, and have been started and stopped more than 400 times. Successful operation of the unit at 1350 F was revealed in 1946, and subsequent tests have included operation for some length of time at temperatures ranging up to 1524 F, this latest announcement reveals.

The performance of the test unit, which includes two gas turbines, an axial-flow compressor, a regenerator, and auxiliary equipment, has been very satisfactory thus far, the operators report. Despite the high temperatures at which the unit has been operated, there have been no failures of blading in the high-temperature turbine zones. Frequent inspections have

revealed no indications that the unit will not have a satisfactorily long operating life.

Heretofore, temperatures as high as 1500 F have been achieved only in short-time tests of turbines operating above their normal design temperatures, or in short-life-cycle machines such as aircraft jet engines, in which the advantages of extremely high power concentration in a small volumetric space and very low specific weight offset the reduced operating life resulting from the high initial gas temperatures applied to lightweight machines. Thus a great deal of previously unavailable information is being obtained from the tests on the Annapolis equipment.

Among the many design innovations being tested in this installation are various methods of applying cooling air whereby high-temperature parts may be cooled to protect them against undue weakening effects of extremely high temperatures. Other design features of the turbines have demonstrated their soundness in enabling the unit to withstand successfully abnormal operating conditions which have occurred during some of the tests.

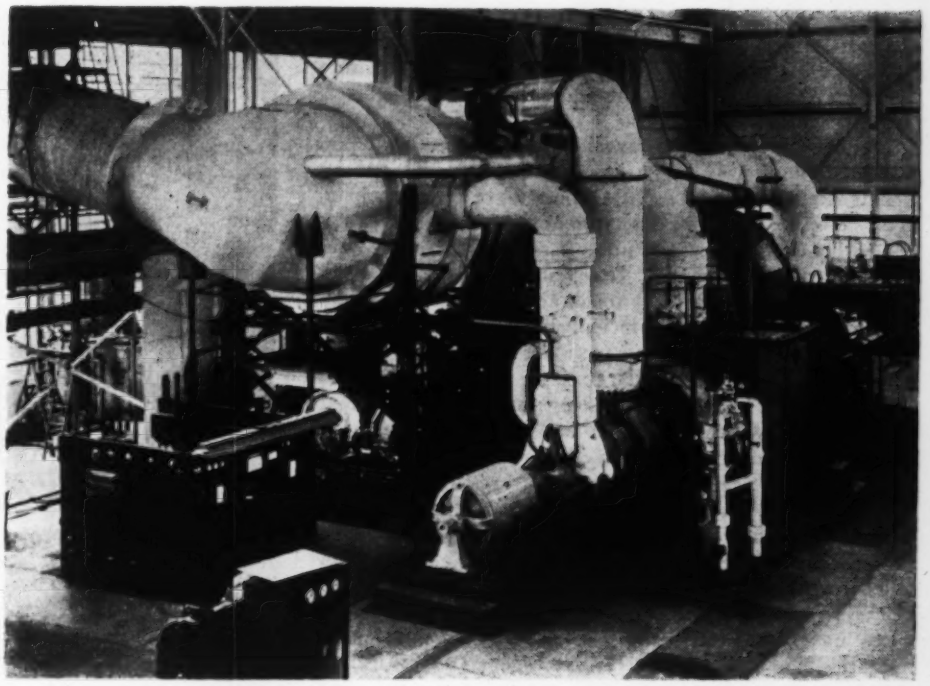

FIG. 7 3500-HP EXPERIMENTAL GAS-TURBINE PLANT

Probably the greatest significance in the successful operation of this unit at a temperature as high as 1500 F lies in the importance of high-temperature operation in increasing gas-turbine thermal efficiency. While spokesmen are careful to emphasize the experimental nature of the Annapolis unit, it is expected that the design, materials application, and operation lessons learned from the continuing testing of this unit will lead directly to improved reliability and efficiency of commercial units, thus helping to bring the gas turbine nearer to full realization of the promise it shows for application in many marine-propulsion and power-generation fields.

Rubber-Top Roads

IN the search for a low-cost method of extending the service life of United States highways, several states have laid test sections of roads using a rubber and asphalt mix, according to C. R. Shaffer, The Firestone Tire and Rubber Company. Tests of such rubber, or rubber-top roads, indicate they can withstand frost and freezes, as well as 100-deg summer temperatures, better than conventional black-top road materials.

Rubber-top roads are made by mixing powdered rubber with asphalt before it is laid onto the roadway. The swelling action of the rubber in this mixture tends to toughen the asphalt and raise its "flow" point. This means that a rubber-top road will not soften as much as an asphalt-top road under the hot rays of the sun.

The binding action of the rubber, when mixed with asphalt, also tends to hold the sand and crushed rock more closely together, thereby sealing out much of the moisture that permeates pavements. By reducing moisture absorption, the rubber-top road is not as vulnerable to frost damage as ordinary asphalt-top roads during the winter months of freezes and thaws.

To date, laboratory and highway tests, supplemented by extensive Far East and European experiments, have indicated that the use of rubber powder in asphalt mixtures greatly improves the durability of black-top highways, and reduces maintenance costs.

Some of the test roads laid before the war in Europe and in the Dutch East Indies still are in good condition, despite their use during the war as military highways when they were subjected to the heavy pounding of all types of mobile armored vehicles Adjacent road sections, made from conventional asphalt mixtures, disintegrated under the heavy traffic.

In the United States, rubber-top roads have been laid in Ohio, Virginia, Minnesota, and Texas. Many other states are launching projects to explore the advantages that may be gained from the use of powdered rubber in highway construction.

The technique of laying rubber highways is the same as that used in present resurfacing and new highway construction. The only extra step is to mix the powdered rubber, either natural or synthetic, crude or processed, with asphalt topping materials at controlled temperatures. This rubber-asphalt mix then is spread over the surface of the roadbed by standard road-building machinery. No special equipment is required.

Resiliency of the rubber permits the road to "give" under the weight of heavy vehicles and to spring back into shape after they have passed. This minimizes shattering of the road surface from heavy impacts.

Some other advantages, in addition to durability under extreme temperature conditions, include noise reduction, and better nonskid characteristics.

In Worthington, Minn., residents reported that traffic noises seemed to be reduced noticeably after one of the city streets was resurfaced with a rubber-asphalt mixture. Although scientific decibel comparisons have not yet been made to confirm this report, it is logical to conclude that the powdered rubber would act as a sound insulator in roads as well as in automobiles.

Some reports and preliminary tests indicate that rubber-top

roads provide greater protection to motorists by increasing traction. If these findings prove to hold true for all rubber-top roads, such highways will greatly increase the safety factor for motorists by retarding skidding and reducing the number of accidents attributable to skids.

Some of the workers who have helped lay test sections report that there is noticeably less fatigue when walking on the rubber-asphalt sections than on asphalt, concrete, or other road surfaces. If tests prove these observations to be true, another new field will be opened for use of rubber in sidewalks, tennis courts, and children's playgrounds. To investigate these claims, several types of rubber-mix playgrounds already have been laid.

Primarily, however, the principal advantage of rubber roads is economy, not only in longer wear but also in maintenance.

More than half of every dollar spent for highways, according to a recent report by the Brookings Institution, is used solely to maintain roads which already are in use. Most of the other half dollar is used to replace worn-out roadways with new ones. This leaves only a few cents for the construction of the type of modern highway systems so urgently needed to handle present and future passenger-car and truck traffic. If the service life of old roads can be extended by rubber-top resurfacing, state highway departments will be able to spend more money on modern highway-construction programs.

Cost of building rubber-top roads is very economical at the current level of rubber prices. In experimental quantities, it is estimated at about $400 a mile; in volume production, the price of rubber powder probably would be reduced greatly. Even at $400 a mile, however, it is only a small percentage of the cost of new highways or the cost of resurfacing.

Comparative tests now are being made in laboratories and in test sections of roads to determine the relative wearing qualities of natural, synthetic, and processed rubber. The price of each type of rubber also will be important in the decisions of state-highway engineers because consumption conceivably might run into the hundreds of thousands of tons.

Three-Jet Bomber

NEWEST and most radical in design of all the U. S. Air Force's jet aircraft, the Martin XB-51, a three-jet bomber with drastically sweptback wings and T-shaped tail, successfully completed its first flight on October 28, 1949.

The first postwar USAF bomber for the destruction of surface military targets in co-operation with air-ground and/or naval forces, the XB-51 also is the U. S. Air Force's first three-jet airplane. Two General Electric J-47 engines are mounted on pylons on the lower forward sides of the fuselage; the third is carried internally in the rear of the fuselage. Each engine produces more than 5200 lb of thrust.

The airplane's main landing gear consists of two pair of large wheels mounted tandem or bicycle style, retracting into the fuselage. Small outrigger wheels near the wing tips give balance during take-off and landing.

One of the most unusual features of the XB-51's configuration is the location of the horizontal stabilizers, which are mounted T-shape atop the vertical stabilizer and fin in order to be as clear as possible from turbulence created by the wings and forward engines.

The XB-51 is felt to be the answer to the growing demand for an airplane especially designed to work with ground forces—a swift, hard-hitting ship which can blast enemy supply lines and installations for one or two hundred miles ahead of the fighting area.

The XB-51 is operated by a crew of only two men—pilot and radio operator-navigator. Both are in a pressurized, air-conditioned cockpit of the airplane. They use pilot-ejection-type seats.

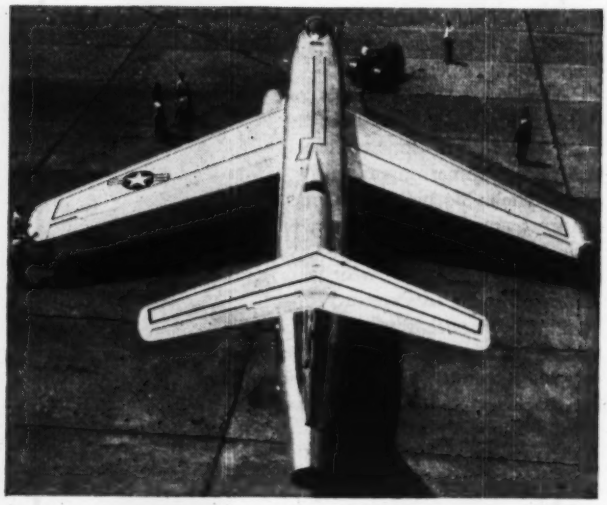

FIG. 8 LOOKING DOWN ON THE USAF'S NEW HIGH-SPEED LIGHT BOMBER—THE MARTIN XB-51

FIG. 9 THE XB-51 SHOWN TAKING OFF ON ITS FIRST FLIGHT

The wings, which have a span of approximately 55 ft, are sweptback at an angle of 35 deg. The fuselage is about 80 ft long, and the height is approximately 17 ft. Lateral control is provided by "spoiler" type ailerons on the upper surfaces of the wings.

No indication of ultimate speed has been given by the Air Force, and many radical features of the XB-51 are still classified under military security regulations.

Guided-Missiles Range

THE National Military Establishment has released plans for what undoubtedly will become one of the most important research facilities in the South, the *Journal of Southern Research* reports. According to a special report from Washington, the NME is now establishing a long-range proving ground for guided missiles, having a launching point in Florida and extending southeast through the Bahama Islands. The facility will be used jointly by the Air Force, Army, and Navy.

Headquarters of the new installation have been set up at the old Banana River Naval Air Station, which has been transferred to the Air Force. The launching site will be on nearby

Cape Canaveral, northeast of Melbourne, in a sparsely inhabited area. The range will extend across Grand Bahama, Great Abaco, Eleuthera, and Cat Islands, passing just south of San Salvador. While present plans call for a length of 500 miles, the range is located so that it might be extended to a length of several thousand miles.

The Air Force has obtained rights to property within a five-mile radius of the launching site, to insure safety and security. Service and access roads are being built. A relay communications tower will be constructed 30 to 40 miles south of Banana River and a main communications tower will be located in the vicinity of West Palm Beach.

With permission obtained from the British Government, observation stations will be built on several of the Bahama Islands. Each down-range station will consist of a communications tower, instrumentation platforms, and buildings to house about 125 people. Each site will consist of 5 to 10 acres.

July 1, 1951, has been fixed as the time that the range should be ready for extensive research use, but limited tests may be made before that date. It is expected that the staff by that date will include approximately 250 officers of the three services, 2500 enlisted men, and 1500 civilians. Most of the personnel assigned to the down-range observation stations will be civilian scientists. Obviously, the facility will furnish new employment for a number of professional men in electronics, physics, electrical engineering, and related fields.

When the proving ground is in full operation, it is contemplated that there will be more than 100 launchings per year. The entire length of the range will be under radar and visual surveillance, to avoid possibility of collision with aircraft or of missiles landing in the vicinity of surface craft. There will be devices to control missile flight continuously. Should these devices fail, the missile will be destroyed in the air before leaving the safe range, or diverted to land at sea.

The idea for the joint range was conceived in 1945 and studies have proceeded continuously. The Committee on Long-Range Proving Ground unanimously approved the site on June 20, 1947, after inspecting numerous locations in the United States.

Portable Photo Copier

A COMPACT portable photographic-copying device designed especially for students—many of whom spend hundreds of hours hand-copying research material—has been invented by Frederic G. Ludwig, chief photographer at Yale University's Sterling Memorial Library. The device, named the Contoura, because it can snap a contact photograph of a book page even where the paper curves into the binding, can be used on either alternating or direct current, and can even be attached to flashlight batteries.

Primarily intended for use in libraries, archives, and other research sources, it is adaptable to business and professional offices wherever fast and inexpensive copying is needed. According to Mr. Ludwig, the Contoura can be operated at a cost of two cents a page.

The device is in an $8 \times 10 \times 2\frac{1}{4}$-in. lightweight metal case. It is just thick enough to contain a layer of six matched electric-light bulbs. The bottom consists of a light-equalization mask and a translucent inflated cushion.

Without this light-equalization mask the lights within the device could not be brought so close to the subject matter being copied, and the Contoura would have to be several inches deeper.

The cushion allows the device to photograph material on the curve of a page. It holds a special slow-photographing paper, used with the device, with equal pressure against all parts of the area being photographed. The cushion can be inflated or deflated as needed.

Mr. Ludwig, who is marketing the device through his own firm, F. G. Ludwig Associates, Woodbridge, Conn., is conducting research to improve a dry developing method which would produce on-the-spot positive prints. According to the inventor, this would make the Contoura a competitor of the photostatic machine. A complete photostat device requires considerable investment and a trained operator, while the Contoura can sell for $35 and can be operated by anyone with a few minutes of instruction.

With conventional wet processing, the Contoura produces reversed negative prints. A built-in mirror is used to read them. Positive prints can be obtained by recopying the material with the device.

To operate the Contoura, the user places a piece of the photo paper on the material selected, puts the device on top of it, and presses a push-button light switch on and off. Timing does not have to be exact and the operation can be done in normal light, because of the special slow paper used. The photo paper is then developed in the conventional manner.

While the device is in operation, the light from the six internal bulbs passes through the equalization mask, the translucent cushion, and the printing paper. It is reflected back onto the photo paper by the white of the page—or other printed matter—being copied. The black print absorbs the light, producing the negative print.

Synthetic-Fuels Plants

SUMMARY reports compiled recently by the Army Corps of Engineers and released by the Bureau of Mines disclose that areas suitable for synthetic-liquid-fuel plants abound in the portions of four states covered by two recent sample surveys.

Survey areas and the raw materials considered in each were: (1) Western Kentucky, strip and underground coal; (2) northwestern Colorado, oil shale and coal; (3) southeastern Texas, natural gas; and (4) southeastern Montana, strip coal.

Results of the sample surveys, which were conducted in part to establish methods and techniques for use in a nationwide survey now in progress, were interpreted by James Boyd, director of the Bureau of Mines, as indicating that there will be ample raw materials and water for plants of large capacity even in semiarid areas of the West. Furthermore, he said, abundant coal reserves were found available without resorting to the use of coking quality coals.

Briefly, the reported findings were as follows:

In western Kentucky, the survey disclosed that the coal reserves available for synthetic liquid fuels total 16,768,000,000 tons—enough to fill the raw-material requirements of either 138 (10,000-bbl-a-day) synthine (modified Fischer-Tropsch) process plants or 164 hydrogenation plants of the same size for 40 years. Water supplies would be adequate for these plants. Western Kentucky is favorably situated with respect to the large oil-consuming centers of the Midwest and could serve these markets either by short pipe lines or by water transportation. Other factors, such as electric power, labor, and housing, would present no insurmountable problems in the development of a synthetic-fuel industry.

In northwestern Colorado, oil-shale reserves yielding 25 or more gal per ton without deep-shaft mining would support for 40 years approximately 105 oil-shale plants, each with a capacity of 10,000 bbl daily. Available coal reserves are adequate to supply 279 synthine plants or 336 hydrogenation plants. Water is a critical resource in this area, however, and

the supply that would be available by 1963 for all new uses would limit the synthetic-fuel capacity of northwestern Colorado to 1,050,000 bbl per day from shale plus from 510,000 to 840,000 bbl per day from coal depending on the processes used. By the end of this century, water available for use in synthetic-fuel plants may approach zero if no priority claims had been established. Markets for any large production in this area would be the west coast and North Central States, and transportation logically would be by pipe line. Such problems as electric power, labor, and housing are difficult but capable of solution.

The study in southeastern Texas showed that the volume of natural gas that might be converted into synthetic liquid fuels totaled $9^1/_2$ trillion cu ft. This would support 14 plants for 20 years, each plant having a capacity of 10,000 bbl a day. Again water supplies are available or could be developed. Under normal conditions, however, there is a very definite question as to the availability of this gas because of economic and conservation considerations involved. Now being recycled to maintain the pressure in petroleum reservoirs, its diversion too soon to another use could result in a considerable loss of natural products.

In southeastern Montana, the Corps of Engineers found mineable coal reserves and water supplies sufficient to support for a 40-year period some 362 synthine plants, each with a capacity of 10,000 bbl a day. Enough low-cost strip coal is present to operate 15 such plants for two decades. The North Central States are the nearest and most logical potential market area for liquid-fuel products.

Mr. Boyd also announced that low-cost methods for mining oil shale in volume have been developed and have removed one of the major deterrents to utilization of this country's mammoth reserves. The results of a recent test run in the experimental mine near Rifle, Colo., revealed that 29,835 tons of oil shale were mined at a direct cost of only 32.9 cents per ton. Average production per man-day totaled 111 tons for underground labor and was 92.7 tons for all labor, including direct supervision, engineering, and maintenance. Until recently, such outputs in underground operations were regarded as virtually impossible. Coal mining is not comparable because of less favorable conditions, but it is interesting to note that average production per man-day in underground coal mines in 1947 was 5.43 tons.

Wage Incentives

THE current interest in wage incentives as a cost-reduction technique were re-examined by Douglas Watson, Jun. ASME, of McKinsey & Company, San Francisco, Calif., during the 1949 Semi-Annual Meeting of ASME. All too frequently an incentive program has been developed because of a current production or cost problem, he said. It has been conceived as a panacea, as a substitute for adequate supervision. Wage incentives have probably provided expedient short-term solutions in some cases—even though the long-range result may be increased costs and lower productivity. The attractiveness of the immediate return in terms of more output, higher worker pay, and lower labor costs often obscures the difficulties in industrial relations and production management that arise in the administration of the plan.

According to Mr. Watson, a wage-incentive plan alone is an imperfect cost-reduction tool for the smaller company or under conditions of rapid technological change. Even though its immediate results may make it very attractive to management, it requires careful planning and administration by capable technicians and better-than-average supervisors to be successful.

Ideally, the installation of a wage-incentive plan should follow improvement and standardization of methods and organization, improved tooling, near-perfection shop scheduling and control, and adequate machine maintenance. Even when this is done there are always technical problems remaining in defining "a fair day's work" and "an average level of output."

A wage incentive paid to direct employees brings up a compensation problem with the indirect workers, a problem which has no ready easy solution.

If we are to reduce costs and become competitive, he said, we must look to other management tools than just a wage-incentive plan. Although they are attractive at first glance the problems of administration are such as to make wage incentives alone an unsatisfactory means to reduce labor costs.

Re-establishment of the foreman as a true supervisor through providing him with adequate standards and management guides will permit and encourage effective cost reduction.

The receptiveness of the foreman to improved methods is increased and his interest in having an economical production unit is stimulated.

Lower-level planning and control encourage the foreman to emphasize those intangible factors that develop an operator's interest in his job. Motivation of this kind is found to be increasingly more effective than a wage incentive alone.

Mr. Watson concluded that wage incentives have been oversold as a cost-reduction tool. Under a properly applied incentive, production costs are frequently lower, but most of the cost reduction can be traced to management's efforts to make the incentive workable, not to the incentive itself. As a means of rewarding the better-than-average worker, a sound wage incentive plan is an excellent management technique. But to reduce costs—look to the properly guided foreman.

Hot-Tinning

A NEW booklet, "Hot-Tinning," by W. E. Hoare, providing complete working instructions for the production of hot-tinned coatings on fabricated articles and components, has been published recently by the Tin Research Institute.

It is essentially a practical manual, compiled primarily to meet the needs of operative tinners, foremen, and design engineers. Considerable attention is devoted to plant requirements and useful hints on plant layout are provided.

The procedures used for cleaning, pickling, and fluxing ferrous and nonferrous metals in preparation for the actual hot-dipping operation are fully dealt with. The composition and characteristics of the various cleaning, pickling, and fluxing solutions, and instructions for their preparation and maintenance are given.

The dip-tinning operation in its various forms is described in extensive detail, since this is of course the central theme of the work. The sections dealing with the actual dipping processes describe techniques for the coating of steel, cast-iron, copper, and other metals in both pure tin and in tin-lead alloys and special attention is given to certain new techniques, developed at the Tin Research Institute laboratories, for the tinning of steel and cast iron.

Methods of minimizing the contamination of tinning baths, for the cleaning and maintenance of the baths, and for the disposal of residues are dealt with, and the booklet concludes with a chapter on the examination of testing of hot-dip tinned coatings and an appendix of useful data and conversion factors.

This publication is obtainable, free of charge, on application to: Tin Research Institute, Fraser Road, Greenford, Middlesex, England; or Tin Research Institute, Inc., 492 West Sixth Avenue, Columbus 1, Ohio.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Civic Responsibility

Recognition of the Engineer, by George M. Muschamp, Mem. ASME, Brown Instrument Company Division of Minneapolis-Honeywell Regulator Company, Philadelphia, Pa. 1949 ASME Annual Meeting paper No. 49—A-47 (mimeographed).

The recognition of the engineer is important because it may mark the necessity of taking actions heretofore contemplated only passively. It is as one who had been performing a stint lower in an organization, then advances and discovers that he is now called upon to lead where formerly he had been following. Characteristically, the engineer will wait for the call. Has the call come? If so, is it being answered? If it is not being answered, how shall it be answered? In examining these questions it is significant to consider both the relationship of the members of the technical family to each other and of the technical family to the remainder of society. These are two of the many variables of which the future of humanity is a function. The principal premises here are that the engineer is a citizen as well as an engineer and he should give increasing attention to society as all citizens should, that he is potentially capable of being a leading citizen by virtue of his training, and that he probably is not doing all he should to assume a leading role.

Machine Design

Ball and Roller-Bearing Identification Standards and Design Selection, by Aaron Hochman, Department of the Navy, U. S. Navy Material Catalog Office, New York, N. Y. 1949 ASME Annual Meeting paper No. 49—A-44 (mimeographed).

The manufacture of ball and roller bearings on modern lines which began about 1900, had not reached an advanced stage of development when it was foreseen that for full expansion of the industry, the major part of the output would have to consist of ranges of universally acceptable external dimensions. Successful co-operation toward this end has been attained by the ISA (International Federation of the National Standardizing Associations) during the last two decades, and has resulted in an international standard for the boundary dimensions of ball and roller bearings. This standard covers a large selection of technically and economically well-balanced bearing sizes. In addition, a general plan for further extension of the system has been worked out. This is intended to form the basis for the selection of dimensions for those sizes and types of bearings which progress in technical development can be expected to require. In addition, standards on tolerance practices have been established and are recognized by many makers and users.

A Joint Army-Navy-Air Force Identification Standard, developed during World War II, has been used within the military services as a uniform classification system for purposes of item identification and cataloging. It has established standardized nomenclature and terminology commonly recognized by military, industry, and manufacturers.

An extremely important use of this identification standard has been in design selection. The Joint Army-Navy-Air Force Standard on Anti-Friction Bearings provides a guide to selection by defining the "standard" constructions, ranges of dimensions, and variations in design normally available within the bearing industry.

The basic concepts of existing International Standards were adopted and expanded to include the wide variety of bearing types and sizes used by American industry, and placed into nine groups.

Each group establishes uniform nomenclature of each basic bearing type or subtype, outlines available standard ranges of dimensions, and expresses, in standardized terminology, normal variations in design or modification of basic bearing. In addition, standardized tolerance tables are included coinciding with existing industrial standards.

All rolling element-type bearings fall under one of two primary classifications, radial or thrust, based on capacity to carry radial or thrust loads. Annular-

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type bearings are designed to carry radial or combination radial and thrust loads, while washer or seat-type bearings are designed primarily for thrust loads only.

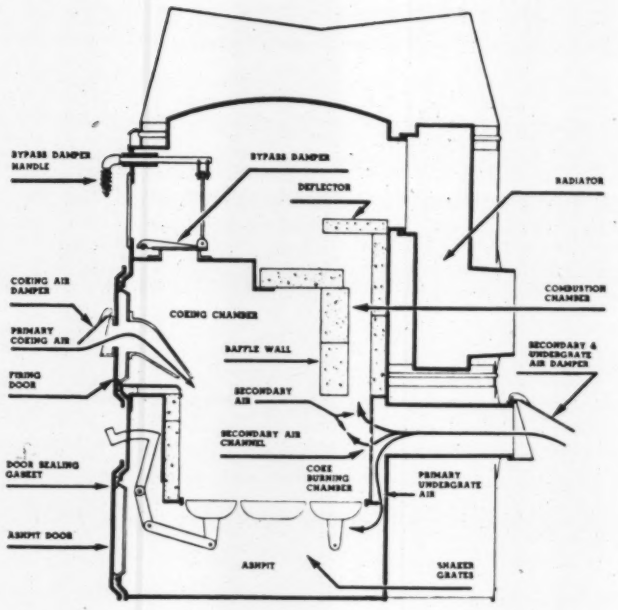
One of the first considerations in selection of bearing type is determination of the appropriate rolling element design. Generally, for small high-speed applications with light load, ball bearings are the most suitable type. For large and heavily loaded applications roller bearings are usually most satisfactory. Roller bearings are further distinguished by variation in construction of the roller to meet specialized requirements. For example, cylindrical roller bearings are well-suited to relatively high speeds due to low-friction characteristics. Tapered roller bearings have high load-carrying capacity radially, as well as axially in one direction. Needle roller bearings are adaptable for variable and intermittent loads and are particularly suitable for applications where oscillation takes place. Spherical, concave, and convex roller bearings are specialized designs providing internal self-alignment of the rolling elements. Journal roller bearings are advantageous due to easy mounting.

Smokeless Furnace

Laboratory and Home Performance of the Illinois Smokeless Furnace, by Julian R. Fellows, Mem. ASME, University of Illinois, Urbana, Ill., and John W. Norris, Lennox Furnace Company, Marshalltown, Iowa. 1949 ASME Annual Meeting paper No. 49—A-28 (mimeographed).

A new type of smokeless furnace which has been developed during the past four years is described and discussed. The paper also includes descriptions of a new two-stage barometric draft regulator and a new semiautomatic hold-fire damper, data taken while one of the new furnaces was being operated under controlled conditions in a laboratory, an analysis of room-temperature records taken in a home heated by a unit operated under all types of weather conditions, and a summary of the experiences of a considerable number of householders who have used the furnace without any supervision from an experienced operator.

The new furnace is arranged to use a maximum proportion of parts which are of conventional design. The grates are a type known as locomotive, which have been used for many years in conventional hand-fired furnaces. The grate ring is of conventional construction except that it is notched to provide passages of definite area through which the primary undergrate air passes into the ash pit. The refractory lining of the circular firepot is of conventional construction except that a portion of it is replaced by the secondary-air channel. The body, radiator, bonnet, and hood are all similar to corresponding parts of conventional furnaces.



VERTICAL CROSS-SECTIONAL VIEW OF SMOKELESS FURNACE

The baffle wall, secondary-air channel, combustion flue, deflector, and by-pass damper are all additional parts needed to promote smokeless combustion of the gases which are present in all of the different types of bituminous coal. Sealing gaskets are provided on both the firing door and the ash-pit door to eliminate leakage at these points and facilitate the control of the combustion air. A specially designed linkage between the mechanism which operates the by-pass damper and the arrangement for clamping the firing door eliminates the chance that an operator may fail to close this damper and thus destroy the effectiveness of the baffle wall and co-operating parts. The operation of this connecting linkage is such that the by-pass damper must be closed before the firing door can be clamped. Furthermore, the firing door will not remain in a closed position unless it is clamped.

A summary of indoor and outdoor temperature data for a continuous period covering one half of a complete heating season indicates that in many private homes a smokeless furnace of reasonable proportions will practically never require attention more often than once a day.

An inspection of 26 field installations indicates no serious problem in regard to failure of parts essential to the smokeless principle, and the comments of the owners show that the furnace is easy to fire and that fuel consumption is satisfactorily low in practically all cases.

Applied Mechanics

Critical Load of Columns of Varying Cross Section, by W. T. Thomson, Mem. ASME, University of Wisconsin, Madison, Wis. 1949 ASME Annual Meeting paper No. 49—A-1 (in type; to be published in the *Journal of Applied Mechanics*).

A method is developed for determining the critical load of a pin-ended long column of n different cross sections and lengths. For n less than 5, the method results in a simple equation for the critical load. Specific examples for columns of 2, 3, and 4 sections are given, and experimental data are presented for comparison.

Gaskets and Bolted Joints, by Irving Roberts, Mem. ASME, Elliott Company, Jeannette, Pa. 1949 ASME Annual Meeting paper No. 49—A-2 (in type; to be published in the *Journal of Applied Mechanics*).

This paper consists of a study of the loading requirements of gaskets in bolted joints, with the object of developing a rational basis for design of such joints. Starting with an analysis of gasket conditions for tightness, the gasket factor m is defined, and its variation with initial gasket stress and gasket width is predicted. These trends are confirmed by a survey of the available-literature data.

In a bolted joint, gasket stress becomes a function of the elastic constants of the system. Equations are derived to predict gasket and bolt stresses resulting from application of internal fluid pressure, and typical elastic recovery curves for an asbestos gasket are presented. Consideration is given to the effect of gasket creep in a bolted joint, and to the problem of distribution of bolt load, for which an approximate theory is derived.

On this basis, defects in the ASME Code are pointed out, and a tentative new design procedure is proposed. Finally, a summary of data which should be obtained for use with the new design procedure is given.

Some Experiments on the Interaction of Shock Waves With Boundary Layers on a Flat Plate, by F. W. Barry, Jun. ASME, A. H. Shapiro, Mem. ASME, and E. P. Neumann, Jun. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1949 ASME Annual Meeting paper No. 49—A-3 (in type; to be published in the *Journal of Applied Mechanics*).

Experimental results are presented in the form of schlieren and interferometer photographs showing the interaction of oblique shocks with laminar and turbulent boundary layers on a flat plate in a supersonic stream. The effects of variations in shock intensity and boundary-layer thickness were studied through a Mach number range of 2.0 to 2.5. A greater variety of shock boundary-layer interactions was discovered than had hitherto been suspected. The nature of the interaction was found not to be solely dependent upon whether the boundary layer is laminar or turbulent. A laminar layer proved to be more greatly affected by an incident oblique shock than a turbulent layer. With relatively intense shocks the boundary layer was influenced far upstream of the point of incidence. Injection of a high-speed air stream into a turbulent boundary layer altered significantly the manner of reflection of an incident shock.

Bending of an Elliptical Plate by Edge Loading, by W. A. Nash, Jun. ASME, University of Notre Dame, South Bend, Ind. 1949 ASME Annual Meeting paper No. 49—A-4 (in type; to be published in the *Journal of Applied Mechanics*).

A series solution is presented for the problem of the small deflections of a thin elliptical plate with the following boundary conditions: (a) The edge of the plate is supported and is given a small prescribed deflection in a direction perpendicular to the middle plane of the plate. (b) The external load applied to the plate consists of a general distribution of bending moments acting around the edge of the plate. Since the loading consists of moments distributed around the edge of the plate, the general Lagrange differential equation for the middle surface of the plate reduces to the biharmonic equation. Elliptic co-ordinates are used and the problem reduces to finding a solution of the biharmonic equation, in elliptic co-ordinates, which satisfies the boundary conditions. Solutions to this equation are of two types: (a) Harmonic functions; and (b) biharmonic functions which are not harmonic. Functions of type (a) are found by the method of separation of variables in Laplace's equation expressed in elliptic co-ordinates. Functions of type (b) are found by the use of complex variable theory.

A Quantitative Comparison of Flow and Deformation Theories of Plasticity, by P. G. Hodge, Jr., and G. N. White, Jr., Brown University, Providence, R. I. 1949 ASME Annual Meeting paper No. 49—A-5 (in type; to be published in the *Journal of Applied Mechanics*).

The stresses and displacements in a partly plastic, infinitely long, hollow cylinder are obtained according to the flow type of stress-strain law of Prandtl-Reuss and to the deformation law of Hencky. In both cases the Mises yield condition is used and the compressibility of the material is taken into account. It is shown that under these assumptions the two theories yield substantially the same results for this particular problem, but that one theory or the other may be preferable for computing purposes in certain cases. The results are compared with those of other investigations in which different combinations of stress-strain law, yield condition, compressibility, and end loading were assumed.

Longitudinal and Torsional Impact in a Uniform Bar With a Rigid Body at One End, by A. H. Burr, Mem. ASME, Cornell University, Ithaca, N. Y. 1949 ASME Annual Meeting paper No. 49—A-6 (in type; to be published in the *Journal of Applied Mechanics*).

A uniform bar carrying a rigid body at one end is analyzed for those cases where its other end is struck by a rigid body, and struck by a bar and body, also for the case of sudden application of force at either end. Recurrence formulas are derived in nondimensional form and applied to determine in a finite number of terms the stress equations for striking impact and for a constant-force impact. Some useful theorems and simplifications, applicable to other problems of this nature, are indicated. For striking impact by a rigid body, charts show the time-variation of stress and the maximum stress for a range of physical values of the bar and bodies. Application to the design of bars, helical springs, and shafts is discussed.

An Approximate Solution for Incompressible Flow About an Ellipsoid Near a Plane Wall, by Philip Eisenberg, David Taylor Model Basin, Washington, D. C. 1949 ASME Annual Meeting paper No. 49—A-7 (in type; to be published in the *Journal of Applied Mechanics*).

Using the method of successive images, an approximate solution for the velocity potential is obtained in closed form for incompressible flow about an ovary ellipsoid near a plane wall. The velocity distribution is computed from this solution in two ways. The first computation properly predicts differences in velocities on opposite half-meridians of the ellipsoid. A second method results in a symmetric velocity distribution but is useful for rapid estimates of the average wall effect. Pressure distributions calculated by this theory are compared with values measured on 4:1 and 6:1 ellipsoid models.

A Mechanical Analyzer for Computing Transient Stresses in Airplane Structures, by R. L. Bisplinghoff, T. H. H. Pian, Massachusetts Institute of Technology, Cambridge, Mass., and L. I. Levy, Grumman Aircraft Engineering Corporation, Cambridge, Mass. 1949 ASME Annual Meeting paper No. 49—A-8 (in type; to be published in the *Journal of Applied Mechanics*).

A mechanical-analogy-type analyzer is described which is used for computing the transient stresses in an undamped elastic structure. The two main functions of the analyzer are: (a) To evaluate the stresses due to the deformations of an elastic structure in its various normal modes, and (b) to superpose the effects of the modes with proper regard taken of their phase relations. Function (a) is accomplished by the use of torsional-pendulum simulators, and function (b) by the proper design of the electronic pickup and recording circuits. The analyzer is particularly useful in the determination of dynamic landing stresses in airplane structures.

Acceleration of the Instant Center, by W. J. Carter, The University of Texas, Austin, Tex. 1949 ASME Annual Meeting paper No. 49—A-9 (in type; to be published in the *Journal of Applied Mechanics*).

The acceleration of the members of a mechanism having a "floating link," is not obtainable by the method of relative accelerations. Beskin has given a solution for this problem which involves the determination of the center of trajectory of points on a connecting link. The method presented in this paper makes use of the acceleration of the instant center of velocity, the acceleration of which is dependent only on the velocity of the linkage elements. The method developed may also be used to obtain the accelerations for linkages which normally require the use of Coriolis' law.

Approximate Solutions of Problems of Plane Plastic Flow, by P. G. Hodge, Jr., University of California, Los Angeles, Calif. 1949 ASME Annual Meeting paper No. 49—A-10 (in type; to be published in the *Journal of Applied Mechanics.*)

A method of approximating the stress and velocity fields in problems of plane plastic flow is presented. A general procedure for finding the deformed pattern of an originally square grid is devised and applied to two examples. The results are compared with known continuous solutions and with experiments.

Matrix Solution for the Vibration of Nonuniform Beams, by W. T. Thomson, Mem. ASME, University of Wisconsin, Madison, Wis. 1949 ASME Annual Meeting paper No. 49—A-11 (in type; to be published in the *Journal of Applied Mechanics.*)

A matrix method for the rapid determination of natural frequencies of any nonuniform beam is presented. It accomplishes the same task as that of Myklestad's tabular method with the added advantage of simplicity of formulation and computation. Included in the Appendix is a procedure for the case where the nonuniform beam is represented by a series of uniform sections.

Torsion of Noncylindrical Shafts of Circular Cross Section, by H. J. Reissner, Mem. ASME, Polytechnic Institute of Brooklyn, Brooklyn, N. Y., and G. J. Wennagel, Grumman Aviation Engineering Corporation, Bethpage, L. I., N. Y. 1949 ASME Annual Meeting paper No. 49—A-12 (in type; to be published in the *Journal of Applied Mechanics.*)

The theory of torsion of noncylindrical bodies of revolution, initiated by J. H. Michell and A. Föppl, is stated by a basic differential equation of the circumferential displacement and by a boundary condition of the shear stress along the generator surface. The solution of these two equations by the "direct" method of first assuming the boundary shape has not lent itself to closed solutions in terms of elementary functions, so that only approximation, infinite series, and experimental methods have been applied. A semi-inverse method analogous to Saint Venant's semi-inverse method for cylindrical bodies has the disadvantage of the restriction to special boundary shapes but the advantage of exact solutions by means of elementary functions. By this method, bodies of conical, ellipsoidal, and hyperbolic boundary shapes have been obtained in a simple analysis. One class of integrals leading to other boundary shapes seems not to have been analyzed up to now, namely, the integrals in the form of a product of two functions of respectively axial (z) and radial (r) co-ordinates. A first suggestion of this possibility was given in Love's treatise on the mathematical theory of elasticity. In the present paper, the classes of boundary shapes, displacements, and stress distributions are investigated analytically and numerically. The extent of the numerical investigation contains only the results of single-term integrals for full and hollow cross sections of technical interest. The detailed analysis of the boundary shapes, following from series integrals, presents essential mathematical obstacles. Overcoming these difficulties might lead to a multitude of solutions of interesting boundary shapes, stress, and strain distribution.

Elastic-Plastic Analysis of Structures Subjected to Loads Varying Arbitrarily Between Prescribed Limits, by P. S. Symonds and W. Prager, Mem. ASME, Brown University, Providence, R. I. 1949 ASME Annual Meeting paper No. 49—A-13 (in type; to be published in the *Journal of Applied Mechanics.*)

Very often in practice a structure is subjected to loads consisting of several components, whose respective maximum and minimum values are known, but whose order and instantaneous magnitudes cannot be specified in advance. For example, an airplane wing might be subjected to dead loads, maneuvering loads, gust loads, etc., whose maximum and minimum values can be estimated closely, but which are applied independently in a manner which is not predictable. Again, a machine part might be subjected to unspecified combinations of bending and torsional loads, whose respective greatest and least values only are known. The present paper deals with the analysis of structures of this kind, when plastic deformation in parts of the structure is permitted in order to obtain the most economical design consistent with safety. Emphasis is placed upon the use of a geometrical representation of the instantaneous state of stress in an appropriate "stress space." For simplicity the present discussion is based upon a pin-jointed plane truss as a typical structure. With appropriate changes of language the concepts developed here may be extended to more general structures and to problems of continua.

Stresses and Deflections of Cylindrical Bodies in Contact With Application to Contact of Gears and of Locomotive Wheels, by H. Poritsky, Mem. ASME, General Electric Company, Schenectady, N. Y. 1949 ASME Annual Meeting paper No. 49—A-14 (in type; to be published in the *Journal of Applied Mechanics.*)

From the well-known Hertz theory of contact stresses, where contact is over a finite area, the more elementary two-dimensional case of contact between two cylinders with parallel generators may be obtained as a limiting case by allowing the contact area to become infinitely long in one direction. However, it is easier to obtain it directly; this is done in the paper.

Stability of Flow in a Rocket Motor, by D. F. Gunder, Mem. ASME, Cornell University, Ithaca, N. Y., and Consultant, M. W. Kellogg Company, Jersey City, N. J., and D. R. Friant, Jun. ASME, Picatinny Arsenal, Dover, N. J. 1949 ASME Annual Meeting paper No. 49—A-15 (in type; to be published in the *Journal of Applied Mechanics*).

This paper presents an analytical treatment leading to a criterion for the proper design of liquid rocket motors to insure freedom from the phenomenon of "chugging" without unnecessary increase in fuel-tank or fuel-pump pressures. The most successful of the several methods suggested here is that of Nyquist, which involves a simple conformal transformation. The analytical treatment presented in this paper has been applied successfully in practice to eliminate this type of instability.

Bending Vibrations of a Pipe Line Containing Flowing Fluid, by Holt Ashley and George Haviland, Massachusetts Institute of Technology, Cambridge, Mass. 1949 ASME Annual Meeting paper No. 49—A-22 (in type; to be published in the *Journal of Applied Mechanics.*)

Free vibrations and forced motions due to crosswinds may both create im-

portant problems in the design of pipe lines supported above ground. An analytic investigation, based on simple beam theory, shows that the flow of fluid in such a pipe line produces marked damping tendencies and thus may reduce the severity of loading encountered. The time dependence of the fundamental mode of a simply supported pipe line is calculated for a number of mass-flow rates, the damping being observed to increase rapidly and the frequency to remain nearly constant over the practically important range. A method is outlined for studying forced vibration, higher modes, and other end conditions. Finally the problem is discussed in terms of traveling waves on an "infinite" unsupported pipe line.

Crushing of Aluminum Tubes Under Hydrostatic and Localized Pressure, by E. Creutz, Carnegie Institute of Technology, Pittsburgh, Pa. 1939 ASME Annual Meeting paper No. 49—A-23 (in type; to be published in the *Journal of Applied Mechanics*.)

In the theory of elasticity, equations have been derived by Sturm and Timoshenko for the crushing strength of long tubes subjected to external hydrostatic pressure. These equations have been found to fit experimental data on steel tubes, provided the length is several times the diameter, and the ratio of diameter to wall thickness exceeds about 30. No similar test data had been taken on aluminum tubes so an experimental study was carried out to determine whether the equations mentioned would apply. No satisfactory correlation was found to exist, but a simple equation was derived which is well within the reproducibility of the test results.

The Flow and Fracture of a Brittle Material, by L. F. Coffin, Jr., Mem. ASME, General Electric Research Laboratory, Schenectady, N. Y. 1949 ASME Annual Meeting paper No. 49—A-24 (in type; to be published in the *Journal of Applied Mechanics*).

The mechanism of flow and fracture of a gray cast iron can be understood if one considers the microstructure to consist of a ductile structure with a random dispersion of cracks due to the graphite flakes following the concept of Fisher. A notch effective stress can be calculated for a critically situated crack by a knowledge of the external stresses, a plastic stress-concentration factor of 3, and a residual tensile stress at the sharp edge of the crack, based upon either the "maximum-shear" theory or the "distortion-energy" theory. This allows the formulation of generalized plastic stress-strain relationships and renders gray cast iron applicable to the many known solutions for plastic flow of ductile metals. Fracture in the region of tension-tension and tension-compression can be evaluated by a similar analysis, using the same stress-concentration factor and the same residual stress. A combined stress-testing program is described wherein thin-walled cast-iron tubes are subjected to two-dimensional states of combined stress covering the complete two-dimensional field.

Fluid Meters

Influence of Compressibility on Cylindrical Pitot-Tube Measurements, by L. W. Thrasher, Jun. ASME, Arabian-American Oil Company, San Francisco, Calif., and R. C. Binder, Mem. ASME, Purdue University, West Lafayette, Ind. 1949 ASME Annual Meeting paper No. 49—A-31 (in type; to be published in Trans. ASME).

In the cylindrical Pitot tube, an opening at the critical angle with the flow gives the static pressure. For small-diameter tubes this critical angle is $39^1/_4$ deg for incompressible fluids in a certain range of turbulent flow. Using a wind tunnel, the distribution of pressure was measured on the surface of $^1/_8$-in. and $^3/_{16}$-in-diam cylinders at Mach numbers ranging from 0.13 to 0.87. The change in the pressure distribution on the surface of the cylinders was small in the range of Mach numbers up to 0.25. In this range the critical angle was constant, and a simple cylindrical Pitot tube would be convenient for direct measurements of static pressure. At the higher Mach numbers, particularly above 0.4, the critical angle increases above that for incompressible flow. The directional accuracy of the cylindrical Pitot increases as the Mach number increases.

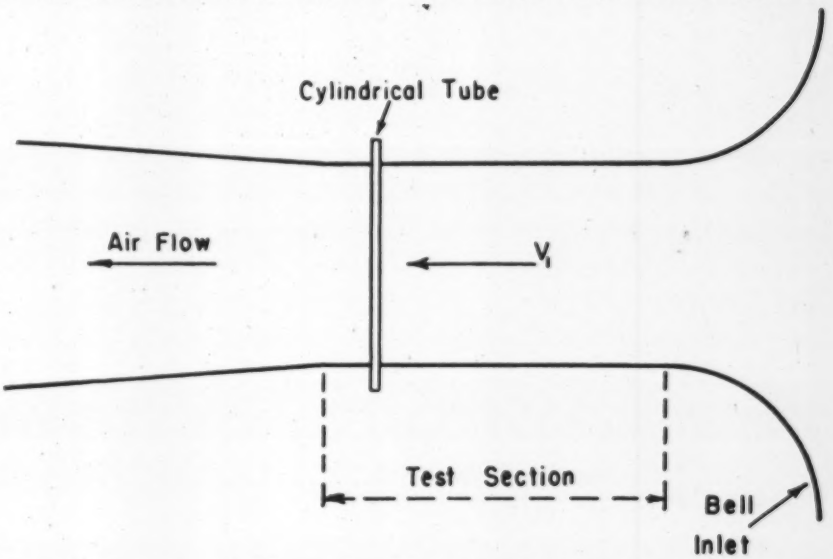
Rubber and Plastics

Theory of the Mechanical Properties of Hot Plastics, by Samuel J. Lorgin, Mem. ASME, Stratford, Conn. 1949 ASME Annual Meeting paper No. 49—A-60 (mimeographed).

The mechanical stress-flow properties of hot plastics are of considerable practical importance in the study of various plastic manufacturing processes, such as extruding, molding, and injection molding. The results of a series of tension tests on several hot plastic materials indicate that the flow properties of these materials result from a rubberlike large-deflection elasticity combined with a stress-relaxation property.

A theory of the mechanical behavior of materials exhibiting large strain elasticity and stress relaxation is developed in this report and consideration is given both to the geometrical properties of large strain and to the nonlinearity of elasticity and relaxation which accompany large strain.

The theory is based upon the mathematical treatment of large strain and differs from most other treatments of large strain in that it is developed from the specification of the state of strain at the individual points of a body rather than a general specification of the state of distortion of the body as a whole. The strain at the individual points is then related differentially to the distortion of the body as a whole by specify-



DIAGRAMMATIC SKETCH OF WIND TUNNEL

ing its time rate of change in terms of flow velocities. This point of view appears simpler than the usual one because the current strain condition can be followed during the course of a deformation without the complexities and ambiguities that arise in relating the positions of points in the body directly to their original or unstrained positions.

The mathematical specification of general elastic and relaxation properties is developed from a phenomenological and macroscopic point of view. It is pointed out that numerical implementation of this specification requires data relating to the internal structure of the materials.

A simple molecular representation of internal structure is set up and analyzed by the methods of statistical mechanics to illustrate the structural significance of the phenomenological concepts introduced to describe the macroscopic mechanical behavior. This analysis leads to definite mathematical functions which describe the elasticity and relaxation of the simplified representation, and which may be used as starting points for interpretation of test data on actual materials.

General solutions for the steady-state flows in channels and tubes are developed, and their numerical application is illustrated by carrying out numerical computations with strain energy and relaxation functions. Comparison is made with some test data on flows through channels and tubes, and the agreement with the theory is encouraging.

Wood Technology

Finishing Piano Cases in Production, by Carl Lusch, Lester Piano Company, Inc., Lester, Pa. 1949 ASME Annual Meeting paper No. 49—A-77 (mimeographed).

The finishing of pianos presents a whole series of problems that are different from those encountered in finishing furniture, radio-television cabinets, or burial caskets. These problems are not necessarily more difficult but distinctly different in many respects.

First, the high criterion of quality which the ultimate consumer has grown to expect of piano finish.

Second, a piano presents many large flat surfaces completely devoid of ornamentation other than the figure and character of the veneer which must be accentuated and enhanced by the finish in order to present the most pleasing appearance possible.

Third, the generally accepted procedure of most manufacturers to finish and, in many instances, even rub piano-case parts before assembly of the case to the back; and to perform the many hours of handwork required to install, regulate, test, tune, and inspect the working units of the piano.

The general concept of piano-case finishing is as follows:

Sanding of case parts prior to finishing must be excellent.

The color of the stain is of prime importance and should be designed to enhance the beauty of the specific case for which it is to be used.

Filling of piano cases is of the utmost importance because the large unbroken flat surfaces are so positioned on a piano that open pores or pinholes become glaring defects.

To achieve uniformity and depth of color the filler is sanded and an overstain is applied by wiping.

The foregoing are the foundations upon which the final operations rest and, to a great degree, determine the final appearance and durability of the finish. The lacquer to be used must satisfy the following requirements: transparency, adhesion, mar resistance, ability to withstand changes in both temperature and humidity, resistance to alcohol and other solvents, as well as for the rubbing characteristics.

Rubbing and polishing complete the operation.

The cold check test consists of exposing finished pieces to a temperature of —5 F for 1 hour followed immediately by exposure to 120 F for 1 hour. This is usually referred to as one cycle. The piece is examined for checking after each cycle. A "check" is a crack in the finish across the grain which can be easily detected by the eye without magnification. The test specimen is subjected to additional cycles until at least three good-sized checks appear on the surface. The number of cycles is then noted and the finish is said to have passed that many "cold check cycles."

Mercury-Vapor Properties

Thermodynamic Properties of Mercury Vapor, by Lucian A. Sheldon, Mem. ASME, General Electric Company, Schenectady, N. Y. 1949 ASME Annual Meeting paper No. 49—A-30 (mimeographed).

Since more and more power stations are being installed to utilize mercury vapor, a revised table on the thermodynamic properties of mercury vapor has been compiled. Even though further experimental work is desirable along certain lines, the residual error in the table as now presented is believed to be smaller than in the 1924 table, which was proposed by W. L. R. Emmet. This new table is currently being used in the design of power-plant apparatus for the mercury cycle.

The figures given in this table are based on values of the heat of the liquid and the enthalpy of saturated vapor obtained by the Research Laboratory of the General Electric Company at Schenectady, N. Y.

The specific heat of mercury vapor is taken as a constant ($C_p = 0.02474$) which corresponds to a value of $5/2(R)$ per mole for a monatomic gas. This approximation has been used to extrapolate the superheat region to 1400 F.

The figure selected, 0.02474, leads to a negative Joule-Thomson coefficient when combined with the experimentally determined enthalpies of saturated vapor. However, the supposition of zero or positive values of the "cooling effect" leads to questionably high values of specific heat. More experimental values are needed to establish definitely the correct values of specific heat. But the uncertainty in enthalpy due to this question appears to be so small as not to affect the utility of the Mollier diagram for proportioned thermodynamic working cycles.

The usefulness of the values in the saturated and moisture region have been justified by the performance of the several mercury-vapor power plants which have been in operation over the past 20 years.

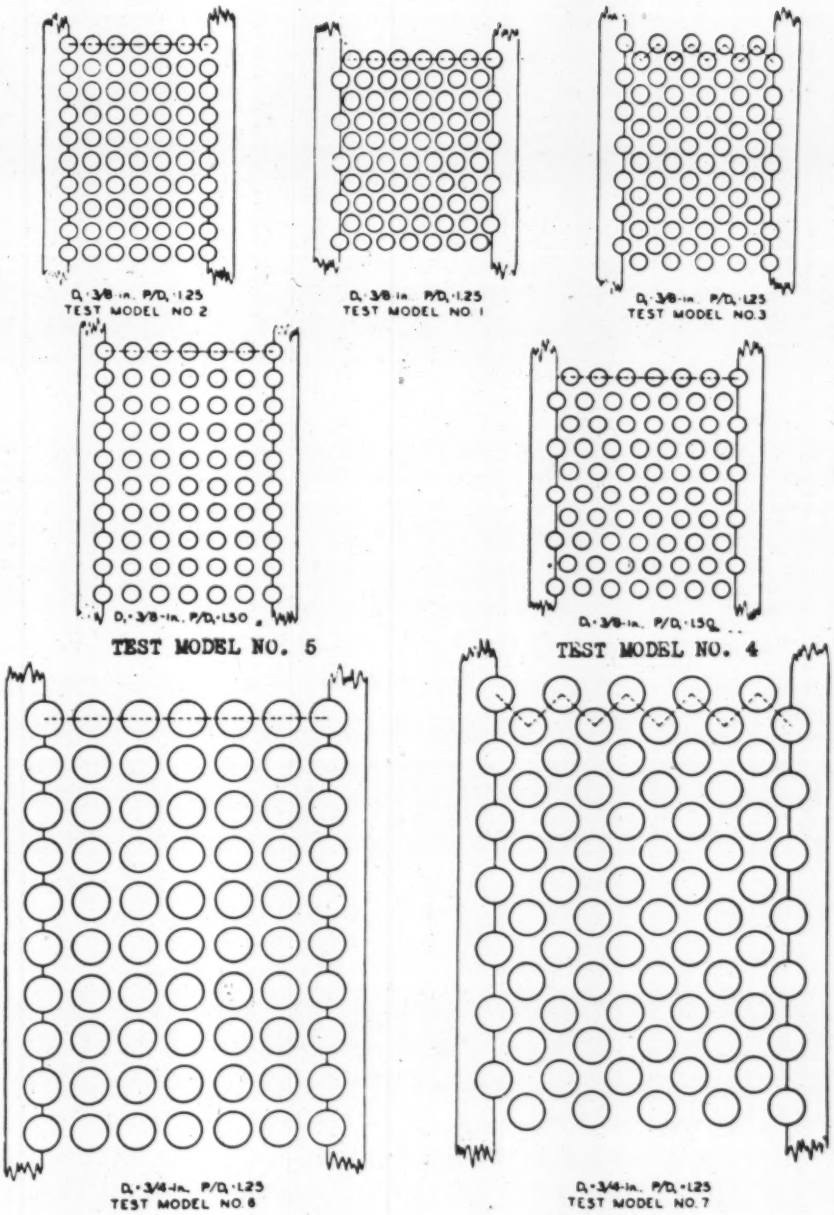
The basic relationships utilized in the preparation of this table, and the table, are contained in the paper.

Heat Transfer

Heat Transfer and Fluid Friction During Viscous Flow Across Banks of Tubes. III—A Study of Tube Spacing and Tube Size, by Prof. O. P. Bergelin, G. A. Brown, H. L. Hull, and F. W. Sullivan, University of Delaware, Newark, Del. 1949 ASME Annual Meeting paper No. 49—A-87 (mimeographed).

In the course of a research program on tubular heat exchangers, pressure drop and heat-transfer data are reported for heating and cooling a medium-viscosity oil flowing across banks of vertical tubes in seven test exchangers. The apparatus variables include equilateral triangle, in-line square, and staggered-square arrangements; tube sizes of $^3/_8$ in. and $^3/_4$ in. outside diameter; and pitch ratios of 1.25 and 1.50.

The results are shown both in simple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TEST MODEL NO 8
D, 3/4-in. P/D, 1.25
TEST MODEL NO 7

TUBE-SHEET LAYOUTS

plots of pressure drop and coefficient of heat transfer versus the rate of flow and in generalized correlations. Tentative correlations are provided for friction and heat transfer which bring the data for these seven tube banks somewhat closer together than previous correlations. In a comparison of the heat-transfer coefficient versus pumping power loss per unit surface area, the smaller-diameter tubes at the smaller pitch ratio gave the best performance.

The data indicate the following:

1 When the pitch is increased for a given arrangement and tube size: At constant velocity the pressure drop is lower, at constant velocity the coefficient of heat transfer is lower, and at constant pumping power loss the coefficient of heat transfer is slightly lower.

2 When the tube diameter is increased for a given arrangement and a constant-pitch ratio: At constant velocity the pressure drop is lower, at constant velocity the coefficient of heat transfer is lower, and at a constant pumping power loss the coefficient of heat transfer is considerably lower.

3 The highest coefficients of heat transfer were obtained with the smaller tube sizes and the small tube pitches in the staggered arrangements.

4 A modification of the method of Chilton and Genereaux utilizing the volumetric equivalent diameter gives the best correlation of the pressure drop for viscous flow across the seven tube banks tested, although separate lines are found for the two pitch ratios.

5 The use of the volumetric equivalent diameter in the Reynolds number gives a somewhat better correlation of the heat-transfer data than does the use of tube diameter.

Super Tankers

The Design of a Class of 28,000-ton Tankers, by H. De Luce and W. I. H. Budd, Bethlehem Steel Company, Quincy, Mass. 1949 ASME Annual Meeting paper No. 49—A-97 (mimeographed).

Twenty-four "super tanker" type vessels, providing 28,000 tons deadweight and a sea speed of 16 knots, are being constructed for the transportation of crude oil from Persian Gulf ports to the Atlantic Coast of the United States, and transportation of light petroleum products in the domestic trade from Gulf ports to Atlantic Coast ports such as Philadelphia or New York.

In considering the draft limitation imposed by use of the Suez Canal, which is 34 ft, a design draft of 33 ft, molded, was selected.

Some of the general dimensions and other characteristics are as follows: overall length, 624 ft 7 in.; length between perpendiculars, 595 ft; breadth, molded, 84 ft; displacement, molded, in S.W., 36,044 tons; displacement total in S.W., 36,280 tons; light ship weight, 8110 tons; liquid-cargo capacity (tanks 100 per cent full), 241,500 bbl; dry-cargo capacity (bale), 78,000 cu ft; fuel capacity (maximum), 26,550 bbl.

The necessity of large bunker capacity for the Persian Gulf service and the equal importance of large cargo tank volume when in domestic service, suggested the conversion of some of the cargo space volume to bunker space when in the Persian Gulf trade. This was particularly feasible inasmuch as the relatively high density of the crude-oil cargo brought in from Persia results in considerable outage.

Twenty of the twenty-four vessels of this class have bulkheads constructed of Bethlehem-Frear fluted plates but one group of four vessels has flat plate bulkheads.

The basic design of the upper deck provides no sheer except that at the ends resulting from camber.

The compartmentation is common to all vessels except for one group of five ships which have a somewhat different arrangement.

The length of the cargo space is 370 ft, or 62 per cent of the length between perpendiculars. A uniform transverse spacing of 10 ft was adopted with a maximum length of cargo tank of 40 ft. The resulting subdivision of the cargo space provides thirty cargo tanks of which nine are 30 ft long and the remainder 40 ft. The longitudinal bulkheads are located 20 ft off the centerline.

Geared turbines supplied with 600 psig and 850 F steam drive a single shaft and provide for continuous operation at a maximum power of 13,750 shp at 103 rpm. The normal rated power is 12,500 shp at 100 rpm.

The boilers are two-drum type equipped with economizers and superheaters. High-pressure superheated steam is used by the main turbines and turbogenerators. Desuperheated steam is available from drum-type desuperheaters and at sea is used principally to drive the feed pump and air ejectors.

The main propulsion unit consists of a high and a low-pressure turbine driving through double-reduction gears. Three bleeder points are fitted. The high-pressure bleeder supplies the low-pressure steam generator. The intermediate bleeder supplements the feed-pump exhaust as required to supply the deaerating feed heater and the steam air heater. The low-pressure bleeder serves the first-stage feed heater and the low-pressure distilling plants.

Railroads

Railroad Mechanical Testing, by E. D. Hall, Erie Railroad Company. 1949 ASME Fall Meeting paper No. 49—F-28 (mimeographed).

Railroads run three general types of tests: performance tests, service tests, and standard practice or procedure tests.

The performance tests are those made on complete units of equipment, such as locomotives, cars, and machines. In locomotive testing, efficiency tests are made to determine the horsepower output, the fuel efficiency, speed characteristics, including acceleration and ability to handle trains. Usually a dynamometer car is used, which registers continuously the amount of drawbar pull exerted on the first car behind the engine. At the same time gages are used to cover the operation of each part of the locomotive, so that all losses due to accessories and any unforeseen occurrence can be calculated.

Service tests cover a great variety of types of testing, including materials, such as engine bolts, paint, antirust compounds, bearing metals, packing, axles, firebox sheets, wheels, roller bearings, lubricators, sanders, valves, bell ringers, filters, lubricating oil, fuel oil, greases, toilet seats, coach seats, floor coverings, mattresses, and practically every product used by the railroad.

In addition to service tests a certain number of routine checks are being constantly made, checking on the quality of the materials purchased.

Physical tests are made using accepted standard tests methods, and the strength, hardness, and soundness of the material is determined.

Design is studied to determine if original design shortens the expected life of the part. Measurements are taken to determine whether the part was improperly machined or wear was allowed to take place to an excessive degree.

Lubrication

Investigation of Lubricants for Power Circuit Breakers, by R. R. Bush, Mem. ASME, General Electric Company, Philadelphia, Pa. 1949 ASME Annual Meeting paper No. 49—A-17 (in type; to be published in Trans. ASME).

This paper describes a technique for the selection of proper lubricants for power circuit breakers. The circuit breaker is described briefly, and its lubrication requirements for dependable operation are discussed. The laboratory methods set up to determine the performance of the grease best-suited for this application are outlined. Results of the laboratory test data are shown and evaluated with reference to circuit-breaker requirements. Properties of some typical greases are compared with their performance for this particular application.

It is revealed that much investigation is necessary to determine the suitability of a lubricant for any particular apparatus. It is possible to find a grease that fulfills most of the requirements set down for a particular application. For a few very special considerations a special lubricant is necessary. Investigation shows that laboratory tests are the quickest and the most reliable way to check a large number of possible greases for a specific application. Results obtained in an actual circuit breaker gave performance far superior to any of the standard greases previously used for this application. Each application, however, will require its own peculiar tests of several lubricants, and different weights will be given to each characteristic to arrive at an acceptable solution for that application. Life tests then must be made on the apparatus itself to insure that performance on all points is satisfactory. In circuit breakers, such a lubrication investigation has yielded results far better than could have been obtained in any other way.

ASME Transactions for November, 1949

THE November, 1949, issue of the Transactions of the ASME contains the following:

Thermodynamic Properties of Oxygen, Nitrogen, and Air at Low Temperatures, L. C. Claitor and D. B. Crawford (48—A-75)

Zero-Pressure Thermodynamic Properties of Carbon Dioxide, Serge Gratch (48—A-150)

Final Report of the Working Subcommittee of the International Joint Committee on Psychrometric Data, John A. Goff (48—A-151)

The Physical Properties of Air With Reference to Meteorological Practice and the Air-Conditioning Engineer, P. A. Sheppard (48—A-152)

Viscosity and Other Physical Properties of Gases and Gas Mixtures, J. O. Hirschfelder, R. B. Bird, and Ellen L. Spotz (48—A-153)

Experimental Determination of Heat Conductivity for Gases, F. G. Keyes (48—A-154)

Southwark Station Boiler Air-Flow Model Tests and Operation Results, R. A. Lane and E. L. Morrison (48—A-26)

External Corrosion of Furnace-Wall Tubes—III Further Data on Sulphate Deposits and the Significance of Iron Sulphide Deposits, R. C. Corey, H. A. Grabowski, and B. J. Cross (48—A-160)

Methods and Instrumentation for Furnace Heat-Absorption Studies: Temperature and Composition of Gases at Furnace Outlet, Paul Cohen, R. C. Corey, and J. W. Myers (48—A-161)

Modern Control Dynamics and Stability Criteria as Applied to Gyroscopic Speed Detectors With Hydraulic Drive, René Feiss

Mechanical Vibration of Piping Induced by Gas-Pressure Pulsations, R. C. Baird and I. C. Bechtold (49—SA-27)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Heat-Transfer Rates

COMMENT BY G. M. DUSINBERRE[1]

The design of buried-tube installations requires the following:

1 Adequate experimental data on the thermal properties of the earth, and the variation of these properties with seasonal and induced changes in moisture content and temperature.

2 A mathematical technique for using these data in engineering predictions.

The present paper[2] is a valuable contribution to requirement No. 1. It is to be hoped that the author will continue this work. Data on vertical installations would be desirable; also data on reversed operation in summer.

As to mathematical procedure, the author has recognized that calculus methods are useful only for the simplest cases under the simplest conditions. This writer would like to invite the attention of engineers in this field to the advantages of numerical calculation, which permits taking account of actual conditions and requires only arithmetic. With calculus, on the other hand, we usually must oversimplify the physical problem, and even then wind up in a maze of Bessel functions. For a comparison of methods, we may refer to the work of Bottorf and Touloukian.[3]

COMMENT BY WILLIAM A. HADLEY[4]

The author should be commended on his excellent paper which contains much valuable data on ground-coil operation, a subject concerning which until now no reliable operating data have been available in the literature.

The author's concluding statement, "It should be possible to design a heat-absorbing ground-coil system from the data here presented, once the properties of the local soil are known," implies a method of utilizing the data for design purposes which would be valuable, but on close inspection is not self-evident.

If the coil is to operate above freezing, it is presumed from the paper, that line-sink-theory predictions based upon the test data given would be the best method to handle the design of coils having physical dimensions differing from the coil tested. However, most ground coils probably will be operated in climates similar to that of Connecticut because in mild climates an air coil will, in general, prove more satisfactory than a ground coil. The author states that for his installations it was necessary to go to coil temperatures considerably below freezing, which is in agreement with other current data. Furthermore, he indicates that predictions by the line-sink theory do not correlate with experimental results on frozen soil, which is also in agreement with studies the writer is now undertaking.

In fact, at the present time it would appear that thermally actuated moisture migration either alters the thermal properties of the soil enough to give appreciable errors to the predictions or it actually convects a significant amount of heat to the coil.

For these reasons the writer is not too sure on how the data in the report (even though they are very extensive and by far the best published to date) can be used safely to design a ground coil of a different size and in soil of differing properties from the reported conditions. A clarification of the method which the author has in mind would be greatly appreciated.

COMMENT BY A. H. ZERBAN[5]

This paper has provided a valuable set of data by which certain properties of the soil may be determined. If one were to determine the temperatures at the surface of the earth above the buried pipes, he could use the various ground temperatures as a means of calculating a mean value of the thermal diffusivity by considering the cyclic variation. This cyclic variation, taken as approximately sinusoidal, may be used over a period of a day, several days, or a year. For instance, in Fig. 3 of the paper, if a sine curve for a period of 300 hr is taken between corresponding temperatures at 5.68 ft depth, use of an expression for the amplitude of temperature variation at depth x feet

$$\Delta t_x = \Delta_{\text{surface}}\, t\, e^{-x\sqrt{\pi n/\alpha}}$$

would give a means of solving for α, the thermal diffusivity, if the amplitude at the surface were known. Reading from Fig. 3, if

$\Delta t_x = 1$, and $n = 1/300$ cycle per hr

$$1 = \Delta_{\text{surface}}\, t\, e^{-5.68\sqrt{\frac{\pi}{300\,\alpha}}}$$

Supposing that a surface amplitude of 25 deg had been measured, solving the foregoing equation gives $\alpha = 0.0324$ sq ft per hr, and if a specific heat of 50 Btu per cu ft of soil is taken as typical, the thermal conductivity would be 1.62. This would agree well with the author's values in Table 1.

In still another manner, an expression for time lag between the surface and depth x

$$\Delta\theta = \frac{x}{2}\sqrt{\frac{1}{\alpha\,\pi n}}$$

would be interestingly applied. With the value given for $\alpha = 0.0324$, on an annual cycle, the time lag at 5.68 ft would be 832 hr, or about 34 days. In Figs. 4, 5, and 6, for April, May, and June, respectively, the temperature at 5.68 ft rises from 45 to 61 F; if the 54 F isothermal at 40 ft is considered to be the mean, this temperature is reached, at 5.68 ft, about June 1. One might conclude that about 34 days previously (the latter part of April), the surface of the earth at Storrs had this temperature. In a similar manner, the maximum annual amplitude at the surface could be related to that at 5.68 ft.

[1] Department of Mechanical Engineering, The Pennsylvania State College, State College, Pa. Mem. ASME.

[2] "Heat-Transfer Rates—Experimental Determination for Heat-Absorbing Coils Buried in the Earth," by C. H. Coogan, Jr., MECHANICAL ENGINEERING, vol. 71, June, 1949, pp. 495–498.

[3] "Numerical Methods of Analysis in Engineering," by L. E. Grinter and others. The Macmillan Company, New York, N. Y., 1949, p. 118.

[4] Assistant Professor of Mechanical Engineering, Columbia University, New York, N. Y.

[5] Professor of Mechanical Engineering, The Pennsylvania State College, School of Engineering, State College, Pa.

AUTHOR'S CLOSURE

The author thanks Profs. G. M. Dusinberre, W. A. Hadley, and A. H. Zerban for their generous comments.

The author agrees with Professor Dusinberre that data on vertical coil installations as well as data on heat rejection during summer operation would be useful. At the start of the investigation reported, it was decided to study only heat absorption in horizontal tubes because this appeared to be the optimum arrangement for this area and since heat rejection would be encountered less frequently. It was not implied that any one method of analysis must be used, undoubtedly numerical analysis will be useful.

In regard to Professor Hadley's comments on the use of the information and data presented in design, the author did not intend to imply that all the refinements of the problem had been perfected but rather that the major factors which must be considered had been outlined. Undoubtedly thermally actuated moisture migration is an important factor. One should realize, however, that it will probably never be possible to actually size a coil in a given installation exactly due to the variable properties of the soil even in one specific location. It was with these considerations in mind that the author indicated that it should be possible to design a ground-coil system from the information presented.

Professor Zerban has made an interesting analysis of the data on earth temperatures. It should be recognized, however, that computations similar to those of Professor Zerban give apparent rather than true values of the several properties of the soil, since moisture moving through the soil from rain fall or melting snow transports a certain amount of energy and hence affects the thermal diffusivity and thermal conductivity as computed by Professor Zerban from the temperature data.

C. H. COOGAN, JR.[6]

[6] Head of the Mechanical Engineering Department, The University of Connecticut, Storrs, Connecticut. Mem. ASME.

Rotary Multiport Valves

COMMENT BY H. L. BOWERS[7]

The authors are to be complimented on their able presentation of this development in the operation of lift-turn valves.[8] The industry has known for some time that the soft-faced rotor in a lift-turn valve presents certain advantages in the handling of the occasional water containing sand or grit.

In any new product it is necessary to work out details of construction and operation over a period of several years, as the actual service conditions indicate the need for changes in the development.

In discussing a device such as this, one notes certain theoretical considerations which may result in operating difficulties.

The authors have pointed out that with a 10-in. diaphragm valve and 80 psi working pressure, there are approximately 2 tons of force tending to hold the valve rotor in place. This is a point which should be given further consideration because certain ports under the rotor have approximately 80 psi pressure against the bottom of the rotor as well as against the top of it, which effectively neutralizes that pressure. Other ports have the full 80 psi pressure on the top but are exposed only to atmospheric pressure on the underside.

Accordingly, it will take a great deal more force to lift the rotor off the ports that are exposed to atmospheric pressure than from those that have the same pressure on both sides of the rotor. This will result in an eccentric loading of the rotor. When it is lifted, the rotor will leave the ports exposed to atmospheric pressure last. Thus a horizontal component will operate against the vertical lifting shaft, causing rapid wear of the cast-iron cylinder through which the shaft slides. It is possible of course to use a hardened shaft, but this still permits wearing of the cast-iron cylinder through which the shaft slides.

No provision has been indicated for lubricating this shaft and cylinder except by dismantling the valve. Considerable improvement in the operation of the valve would be possible by such a provision, and existing cases of chattering would be corrected.

Permitting the rotor or disk to engage a machined cast-iron seat will not give satisfactory service over a long period of time, and it would be more desirable if this seat were to be made of some corrosion-resisting material, such as bronze or stainless steel. Furthermore, if this seat is damaged, it would be necessary, under the present construction, either to remove the valve and remachine it, or to replace it.

Again, we wish to repeat that valves of this type can be perfected only through many years of study in the field, and it is felt that the merits of this valve can only be proved by several years of field experimentation.

[7] Service Manager, The Permutit Company, New York, N. Y.

[8] "New Development in Rotary Multiport Valves," by N. E. Brice, W. Horodeck, and H. L. Tiger, MECHANICAL ENGINEERING, vol. 71, June, 1949, pp. 473–477.

Tests on V-Belt Drives

To the Editor:

Supplementary tests have been made which confirm the results of tests on V-belts reported in the May issue of the Transaction.[9]

It is of particular importance to note that these supplementary tests on the effect of contact angle were run at a much higher speed than those reported in the paper. They give an added basis for the practical use of the convenient Equation [8] of the paper. This Equation is numbered [1] in the supplement.[10]

Equation [2] in the supplement is a theoretical justification for the use of Equation [1]. This theoretical Equation was given in the original paper.[11]

A report on the original tests also appeared in the Engineering Experiment Station Bulletin No. 135 of The Ohio State University.

C. A. NORMAN.[12]

[9] "Tests on V-Belt Drives and Flat Belt Crowning," by C. A. Norman, Trans. ASME, vol. 71, 1949, pp. 335–347.

[10] "Supplementary Experiments on Belt-Drive Fundamentals," by C. A. Norman, published by The Ohio State University, Engineering Experiment Station. (Copies available by addressing the author or Engineering Expiment Station, The Ohio State University, Columbus 10, Ohio.)

[11] Reference 1, p. 343.

[12] Professor of Machine Design, Department of Mechanical Engineering, The Ohio State University, Columbus, Ohio. Mem. ASME.

Digests of 1949 Annual Meeting Papers

EIGHT pages of digests of papers presented at the 1949 Annual Meeting in New York, N. Y., Nov. 27–Dec. 2, 1949, appear on pages 1047–1054 of this issue.

Subjects covered include gas-turbine power, machine design, applied mechanics, rubber and plastics, wood technology, lubrication, heat transfer, fluid meters, railroads, and the like.

Pamphlet copies of the complete papers are available at 25 cents each to members, and 50 cents each to nonmembers from ASME Order Department, 29 West 39th Street, New York 18, N. Y.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Controlling Factors in Economic Development

REVIEWED BY A. A. POTTER[1]

CONTROLLING FACTORS IN ECONOMIC DEVELOPMENT. By Harold G. Moulton. The Brookings Institution, Washington, D. C., 1949. Cloth, 5¼ × 8 in., xii and 397 pp., $4.

THIS treatise is based upon the author's studies of economic trends during the past thirty years and is a distinctive approach to factors which have progressively offset the limitations of nature and have added new economic gains for man in civilized lands.

Part I of this treatise appraises the forces and factors which accounted for economic progress of the nineteenth and early twentieth centuries. The century preceding 1930 was one of unprecedented economic growth. Dr. Moulton states: "If recorded history were reflected on the face of a clock, the period up to 1830 would represent the time from 12:00 midnight to approximately 11:40 in the morning, while the remaining 20 minutes until noon would represent the century from 1830 to 1930. The astounding fact is that during this 20 minutes economic progress—as measured in terms of the increase in output per man per hour—was as great as that in the entire 700 minutes of the preceding time."

The classical school of economic writers, beginning with Adam Smith, who published his "Wealth of Nations" in 1776, and including John Stuart Mill's "Principles of Political Economy," published in 1848, predicted a static situation in which there appeared to be little hope for the improvement in the lot of the masses. These conclusions were based on the supposed scarcity of the world's resources and the law of diminishing returns. The pressure of population growth was expected to result in the so-called "iron law of wages," which held that living standards will always tend to be pressed down to a minimum of subsistence. The Communist Manifesto by Marx and Engels, which also appeared about 100 years ago, while attaching more importance to capital than did their contemporary classical economists, held to the iron law of wages even more rigidly. The Communist Manifesto held that while labor is being held down to a bare minimum to sustain life, labor's production produces "surplus value" in the form of interest and profit for the benefit of the capitalist exploiters of labor. Marx and Engel did not realize that technologic changes benefit labor as well as capital. These economists of a century ago failed to recognize the political significance of machinery and other capital instruments as means of increasing production efficiency and raising living standards. John Stuart Mill, writing about one hundred years ago, concluded that: "It is questionable if all the mechanical inventions yet made have lightened the day's toil of any human being."

The astounding improvement in the material well-being of all classes during the past century cannot be explained by the opening of new agricultural or mineral areas or by a decline in population growth. Science, technology, and economic organization, operating directly to increase productive power and to offset limitations of nature, are largely responsible for our economic progress during the past century. Without scientific discoveries and their applications through engineering to the process of production, the predictions of the classical economists might well have operated to prevent any great improvement in living standards. Mechanical power and chemistry have been the equivalent of a new basic factor of production. Science and engineering made possible vast increases in production efficiency and provided the impetus for large-scale business enterprise. Large-scale enterprise was dependent upon the assembling of great aggregations of capital funds, resulting in the development of the limiting liability corporation and the evolution of bank credit.

The author points out that despite the economic achievements of the past century, American business was more or less depressed one third of the time by recessions. Economic disorders cannot be traced to any single cause, and no simple formula has been developed for checking a decline and bringing about a recovery. Bank credit control, either through the medium of interest rates or by loan restrictions, cannot prevent depressions. Neither can fiscal-government policies prevent depressions, but they may prove helpful in relieving distress during periods of economic unbalance.

The factors other than cyclical which have affected economic progress have been analyzed by the Brookings Institution and the results were published in 1934–1935 in four volumes—"America's Capacity to Produce," "America's Capacity to Consume," "The Formation of Capital," and "Income and Economic Progress." A summary of the findings of this study is given by Dr. Moulton with the following major conclusions:

America's production capacity was not being fully utilized; at least one fifth more goods and services can be produced.

There is too great a concentration of income in the higher levels; an expansion of income among the poorer classes would sharply increase aggregate consumer expenditures relatively to aggregate earnings.

The most effective means of modifying the distribution of income is not by high taxation but by altering the stream of flow within the business enterprises, by raising wages, sharing profits, and reducing commodity prices.

Part II of this book analyzes the economic potentialities of the future, keeping in mind the following goals as the primary objectives of national economic policy:

1 Progressively larger total income.

2 Progressively wider division of national income, rather than great concentration in the hands of the few.

3 A society in which individual rewards are based primarily on work performed. The individual should be paid for what he does, and not according to his needs.

4 Increasing economic security to insure the free and independent worker

[1] Dean of Engineering, Purdue University, W. Lafayette, Ind. Fellow ASME.

from periodic loss of income during periods of economic unbalance.

5 Greatest possible development of the capacities of every individual by widespread educational facilities and by freedom of choice of economic activities.

6 Opportunity for every capable individual to earn his own income, rather than to be dependent upon the State for his support.

Alternative types of economic organizations are analyzed with the free-enterprise system and communism at the two opposite extremes, the former relying on the individual to promote economic progress, and the latter emphasizing the top group or state as the source of wisdom and initiative. The American system from its very beginning has emphasized the individual and not the state as the source of power. Under our system of private enterprise, individual initiative and self-interest are relied upon to provide the driving force in productive activity and economic development.

The author calls attention to the new American philosophy which conceives that the function of government should be to control the operation of the economic system, a trend which has been most far-reaching since 1946. Our government, faced with problems of postwar adjustment and reconstruction, elected to retain the vast control mechanism that had been developed to meet the requirements of war. Controlled economy is incompatible with the American system of government, and cannot be effectively administered, but government regulation of certain monopolistic enterprises is possible without usurpation of vital managerial functions.

Looking ahead, scientific agriculture, making maximum use of science, power-driven machinery, and improved production techniques, can triple American food production in the course of the next century. Similarly, invention and scientific discovery, translated by engineers into increased production, should insure an abundance of the world's goods to meet future needs if we can have peace and maintain a type of government which encourages conditions essential to rapid economic progress. Improved living standards are dependent upon efficient production which means the full use of science, technology, improved management policies, and increase in the efficiency of labor. Increase in labor productivity has not kept pace with wage increases since 1933. High productivity will also mean larger and larger business enterprises to permit greater investment in capital goods per man employed and more rapid replacement of present equipment by improved machinery. Finally, the maintenance of a stable dollar unit is essential as is a public debt within manageable proportions. The private-enterprise system would function more vigorously with a tax system which absorbs 10 to 15 per cent of the national income than under one which absorbs 25 to 30 per cent.

Our present world economic disorder may be traced to World War I which thoroughly disrupted the economic equilibrium of the world, the world depression of the 1930's which continued the progress of disintegration, the abandonment of the world monetary system, based on gold, in the 1930's, and World War II which completed the destruction of the world equilibrium.

The author concludes that factors of decisive importance in our future economic growth appear to be not the adequacy of our material resources or the availability of scientific and engineering talent, but rather the inherent difficulties involved in the over-all operation and management of the complex business, economic, and political systems of the modern world.

This book should prove of special interest to engineers and scientists, as well as to college students in those fields who are interested in understanding economic trends and the factors which are conducive to high industrial productivity as well as high living standards.

The Douglas Project

THE DOUGLAS PROJECT. A Comprehensive Report on the Planning, Design, Construction, and Initial Operation. Technical Report No. 10. United States Government Printing Office, Washington, D. C., 1949. Cloth, 5½ × 9 in., 158 illustrations, 436 pages. For sale by TVA Treasurer's Office, Knoxville, Tenn., $1.50.

REVIEWED BY R. E. B. SHARP[2]

THIS report was prepared by the engineering and construction staff of the Tennessee Valley Authority with contributions from other divisions. It forms a companion volume with other published reports in this series, viz. The Norris Project, published in 1939; The Wheeler Project, 1940; The Pickwick Landing Project, 1941; The Guntersville Project, 1941; The Chickamauga Project, 1942; The Cherokee Project, 1946; The Hiwassee Valley Projects, Vol. 1, 1946, Vol. 2, 1948.

A wealth of information and data is given; from an excerpt taken from the 1936 report on the unified development of the Tennessee River by the Board of Directors, TVA, to Congress, to a tabulation of kwhr developed from 1943 into 1948, followed by detailed cost tabulations with appendixes containing statistical information and reports. The Douglas site is located on the French Broad River thirty-two miles above its confluence with the Holston on the outskirts of Knoxville to form the Tennessee. Although recognized as a project that would control a drainage area substantially greater than that controlled by any other tributary in the Tennessee Valley, recommendation for the construction of a multipurpose dam at Douglas was deferred by TVA because of the complex problems attendant upon the creation of a large reservoir on the lower French Broad River. These problems involved, principally, the inundation of about 15,000 acres of fertile, populous, and prosperous bottom lands as well as the acquisition of some 18,000 acres of less productive lands. Nevertheless, the power demand created by World War II emergency resulted in the authorization of this project on January 30, 1942. Under this emergency program eleven additional generating units were installed in main river plants, Douglas and six other tributary dams were constructed, and a large steam-generating plant built. Construction of Douglas was started February 2, 1942, and the first unit started in operation in March, 1943. This is considered by the authors to be a new record for speed for a project of this magnitude, particularly in view of difficult foundation conditions and four weeks delay as a result of two major floods.

The power plant had (at the writing of this report) an installed capacity of 60,000 kw, although this has now (1949) been increased to 90,000. Provision has been made for an ultimate total installation of 112,000 kw. Douglas, in conjunction with other TVA reservoirs, has been operated to advantage in the control of floods. The crest of three floods at Chattanooga has been reduced 10, 12.7, and 10 ft with an estimated saving at that location of $23,509,000. The final cost of the Douglas project through June 30, 1947, totaled $41,800,000 including land, land rights, structures, improvements and equipment, transmission plant, and general plant.

Pertinent data on geology, hydrology, and meteorology are set forth with tabulations of mean weekly discharges

[2] Chief Engineer, S. Morgan Smith Company, York, Pa. Mem. ASME.

from 1903 to 1945. The flow corresponding with a rating of 90,000 kw, as at present installed, is on the order of 12,400 cu ft per sec. On the basis of the average flow from 1918 to 1941, this flow exists for about 12.5 per cent of the time; whereas, for a wet year (1929) this flow exists for about 19 per cent of the time. However, allowing for water releases from the reservoir on all TVA plants downstream, it is estimated that Douglas Dam will increase the system primary power by 43,000 kw and the annual system output by 43,000,000 kwhr.

The powerhouse was located on the right flood plain with the spillway reaching across the river. These structures are flanked by concrete gravity-bulkhead sections. The powerhouse now contains three vertical Francis-type turbines, the first two each being rated at 41,500 hp under 100 ft head, and the third unit 35,500 hp at 80 ft head. The spillway comprises eleven Tainter gates with eight sluiceways for reservoir control during flood season.

The maximum floods of record are 150,000 cu ft per sec, whereas the spillway is designed for 337,000 cu ft per sec on the basis of the theoretical formula of 5000 times the square root of the drainage area. With the drainage area above Douglas Dam equal to 21.2 per cent of the total drainage area above Chattanooga, the French Broad has contributed heavily to all major floods there. As noted, the value of Douglas Dam in protecting Chattanooga has been well demonstrated.

The chapter on design is most complete and embraces earth embankments, concrete structures, gates and sluices, turbines, generators, and all electrical equipment. This is followed by equally detailed chapters on construction plant, construction and reservoir preparations. The direct costs are itemized in chapter 8 in detail. These figures are exclusive of taxes or fixed (interest) charges which would be a heavy item were this project undertaken by private capital.

Books Received in Library

ADVANCED CALCULUS FOR ENGINEERS. By F. B. Hildebrand. Prentice Hall, Inc., New York, N. Y., 1949. Cloth, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 594 pp., diagrams, tables, $8. This book is an integrated presentation of special topics and useful methods of calculus found to be essential to engineers and physicists. The first five chapters are concerned with ordinary differential equations; succeeding chapters deal with ideas and tools of vector analysis, introduce and apply the basic concepts of partial differential equations, and discuss the theory of a complex variable. Problems with answers are included.

ADVANCES IN APPLIED MECHANICS, volume 1. Edited by R. von Mises and T. von Kármán. Academic Press, New York, N. Y., 1948. Cloth, $6 \times 9\frac{1}{4}$ in., 293 pp., diagrams, charts, tables, $6.80. Intended for students and engineers who are unable to follow up all the research papers currently published, this first volume of a series presents six papers on recent developments in the field dealing with the following topics: the mechanics of boundary-layer flow; nonlinear mechanics; elasticity; a mathematical model illustrating the theory of turbulence; numerical methods in wave-interaction problems; and Bergman's integration method in two-dimensional compressible fluid flow.

APPLIED MECHANICS STATICS. By G. W. Housner and D. E. Hudson. D. Van Nostrand Company, Toronto, Canada, New York, N. Y., London, England, 1949. Cloth, $6\frac{1}{4} \times 9\frac{1}{4}$ in., 220 pp., diagrams, charts, tables, $3. Prepared as a textbook for sophomore engineering students, this book presents a logical transition from the elements of mechanics as studied in the general physics course to the more advanced courses in engineering. The first part gives a concise treatment of the general principles of statics. The second part includes a large number of applications of statics to the various engineering fields.

DIAMOND TOOL PATENTS Ia, for Machining Metals and Non-Metallic Substances. By P. Grodzinski and W. Jacobsohn. Second revised edition, April, 1949. Industrial Diamond Information Bureau, London, E.C.1, England. Paper, $7\frac{1}{4} \times 9\frac{1}{2}$ in., 55 pp., diagrams, tables, 10s. This publication contains abstracts of the principal British, American, German, French, Australian, and Swiss patents on all aspects of diamond-tool production and use. An appendix contains specifications on machines and equipment for shaping industrial diamonds.

DIMENSIONS IN ENGINEERING THEORY. By G. W. Stubbings. Crosby Lockwood & Son, Ltd., London, England, 1948. Cloth, $5 \times 7\frac{1}{2}$ in., 107 pp., tables, 7s, 6d. Beginning with a discussion of fundamental units, this elementary work continues with an explanation of the basic principles of dimensions, and the applications of dimensional analysis are dealt with and illustrated. Separate chapters are devoted to the dimensions of the dynamics of rotation of thermal quantities and of electrical quantities.

DUST IN INDUSTRY, Papers read at the Conference at Leeds, September, 28–30, 1948, with the discussions which followed. Society of Chemical Industry, London, S.W.1, England. Stiff cardboard, $8\frac{1}{2} \times 11\frac{1}{4}$ in., 175 pp., illus., diagrams, charts, tables, £2, 2s. This volume contains twenty-three papers and discussions which were presented at a conference on the subject. The papers cover the problems caused by dust in various industries, dust measurement, hazards, and explosions.

ELEMENTS OF STRENGTH OF MATERIALS. By S. Timoshenko and G. H. MacCullough. Third edition. D. Van Nostrand Company, Inc., New York, N. Y., Toronto, Canada, London, England, 1949. Leather, $6 \times 9\frac{1}{4}$ in., 426 pp., illus., diagrams, charts, tables, $5. Based on the author's work of the same title published in 1930, this book is considerably abridged and is designed for undergraduate courses in elementary strength of materials. It covers stresses and strains, moments and deflections, and methods for testing the mechanical properties of materials. New problems are included, with partial or complete answers; standard symbols and abbreviations are used; and some topics have been added, such as plane strain, the use of strain rosettes, etc.

ENGINEERING DEVELOPMENTS IN THE GASEOUS DIFFUSION PROCESS. Edited by M. Benedict and C. Williams. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, $6 \times 9\frac{1}{4}$ in., 129 pp., illus., diagrams, charts, tables, $1.25. This volume describes the engineering devices and procedures developed in connection with the gaseous-diffusion method of uranium-isotope separation. Special plant instruments, vacuum engineering techniques, development of heat-transfer equipment, and processes for absorbing fluorine and uranium fluoride are discussed.

HANDBOOK OF PATENTS. By H. A. Toulmin, Jr. D. Van Nostrand Co., Inc., Toronto, Canada, New York, N. Y., London, England, 1949. Cloth, $6 \times 9\frac{1}{4}$ in., 800 pp., illus., diagrams, maps, $9. Written for the businessman, inventor, engineer, and executive, this handbook deals with the essentials and philosophy of patent law. It furnishes an understanding of the relationship of the patent law to manufacturing, research, and engineering. Each step in preparing and safeguarding a patent is discussed. There are also chapters on foreign patents and the treaties and conventions dealing with patents to which the United States is a party.

HARDENABILITY AND STEEL SELECTION. By W. Crafts and J. L. Lamont. Pitman Publishing Corp., New York, N. Y., and London, England, 1949. Cloth, $6 \times 9\frac{1}{4}$ in., 279 pp., illus., diagrams, charts, tables, $5.50. This book presents a co-ordinated pattern of hardenability theories and calculations. The approach is practical with sufficient theory introduced to explain the practice. The hardenability calculations represent quantitative prediction of behavior for each step in the process of developing reliable qualities in the finished product. Many charts, graphs, and tables are included as well as a bibliography.

HEAT TRANSFER, Volume 1. By M. Jakob. John Wiley & Sons, Inc., New York, N. Y. Chapman & Hall, London, England, 1949, Cloth, $6 \times 9\frac{1}{4}$ in., 758 pp., illus., diagrams. charts, tables, $12. Useful both as a treatise for research workers and as a textbook, this volume shows the development of ideas which have led to the present knowledge of the subject of heat transfer. There is a parallel treatment of conduction, convection, and radiation. The first part of the book contains the basic equations; the second part deals with the pertinent properties of matter; succeeding

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

sections provide the solutions and applications of the equations to various types of heat flow. An extensive reference list is included.

HELICOPTER ENGINEERING. By R. A. Young. Ronald Press Company, New York, N. Y., 1949. Cloth, 6 × 9½ in., 255 pp., diagrams, charts, tables, $10. This book presents a summary of accepted design methods based upon both theory and the results of research by many organizations. Derivations are given where necessary, and extensive use is made of graphical curves, charts, and other diagrams. Numerous references and a glossary of terms are included.

INTRODUCTION TO INDUSTRIAL MANAGEMENT. By F. E. Folts. Third edition. McGraw-Hill Book Company, Inc., New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, 6 × 9¼ in., 648 pp., diagrams, charts, tables, $5. Centered around concrete business situations, the text familiarizes students with the problems of industrial management and trains them in the application of principles. This third edition is revised and brought up to date including the experience gained during World War II and the reconversion period. New problems and a new chapter on wage determination have been added.

PHYSICS OF RUBBER ELASTICITY. By L. R. G. Treloar. Oxford University Press, New York, N. Y.; Clarendon Press, Oxford, England, 1949. Cloth, 5½ × 8¾ in., 254 pp., illus., diagrams, charts, tables, $6. This volume presents a concise survey of the theoretical and experimental aspects of the subject. The statistical or kinetic theory of elasticity is developed and applied. There are discussions of the phenomena of crystallization, stress relaxation, and flow, the dynamic properties of rubber, and the solution of engineering problems, involving large elastic deformations. Approximately 150 literature references are included.

RAILWAY AND OTHER STEAMERS. By C. L. D. Duckworth and G. E. Langmuir. Shipping Histories Ltd., 62 Vincent Street, Glasgow, C.2, 1948. Cloth, 5½ × 8½ in., 340 pp., illus., tables, 30s. Brief descriptions are given of the steamships operated by the various British railway companies and some continental companies (Belgian, Danish, etc.) from about 1840 to the present. Nearly 100 illustrations are included. The latter part of the book is devoted to a tabulation of the fleets, which are treated in accordance with their ownership prior to the nationalization of the British railways in January, 1948.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is submitted to the Board on Codes and Standards, as authorized by the Council of The American Society of Mechanical Engineers, for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of September 23, 1949, and approved by the Council under the date of November 4, 1949.

CASE No. 1064 (*Reopened*)

Change the wording of the sentence beginning in the fifteenth line of paragraph 9 on page 134 as follows:

The brazing shall be done by placing the flux if used and the brazing material on one side of the joint and applying heat until this material comes entirely through the lap and shows uniformly along the seam on the other side. If any is used sufficient flux must be applied to cause. . .

CASE No. 1104

Inquiry: May the edge of a head to be placed concave to pressure, or the edge of the shell, which is to be welded to such a head or to an adjacent shell ring, be offset or crimped inwardly so that the offset edge of the material forms in effect a backing strip and leaving the head and shell substantially in line as shown

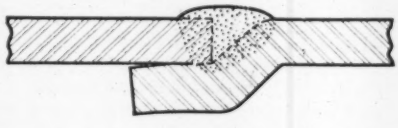

FIG. 1

in Fig. 1, thus permitting the application of a butt weld?

Is the distance from the tangent point of the knuckle to the edge of the weld to meet a minimum requirement?

Reply: Flanges of heads concave to pressure and the adjacent edges of cylindrical shells may be prepared for a welded joint by an offset in which the edge so formed will lap the edge of the adjacent plate, and the groove thus provided may be welded up in the usual manner. See Par. U-75 for length of flange required to edge of weld.

CASE No. 1105

Inquiry: Under Par. P-112(c), where a tube is 4 in. or less in diameter and the thickness is minimum, may it be recessed not to exceed 1/32 in. for a backing ring, provided an equivalent amount is added to the required outside weld reinforcement?

Reply: It is the opinion of the Committee that since the recess in a tube 4 in. or less in diameter will not exceed 1/32 in. and the reduction in the net section will be replaced by weld metal in the reinforcement, the intent of the Code will be met.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph numbers to identify their location in the various sections of the Code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

Add the following to Par. P-289 as follows:

WHEN A SAFETY VALVE IS EXPOSED TO OUTDOOR ELEMENTS WHICH MAY AFFECT OPERATION OF THE VALVE, IT IS PERMISSIBLE TO SHIELD THE VALVE WITH A SATISFACTORY COVER. THE SHIELD OR COVER SHALL BE PROPERLY VENTED AND ARRANGED TO PERMIT SERVICING AND NORMAL OPERATION OF THE VALVE.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

AIEE Poll Seeks to Determine Future Policy

Question: Should AIEE Expand Into Nontechnical Fields?

WHETHER a professional engineering society should limit itself to scientific and educational activities or should conceive its responsibility as extending into those social, economic, and political fields wherein engineers may have an interest is a question currently being debated on the local-section level by members of the American Institute of Electrical Engineers.

The question became a live issue among AIEE policymakers last spring by the introduction of the Smith Resolution and more recently on the local level by an October ballot addressed to the entire membership. How electrical engineers will answer the question will have significance for American engineering. It may be an indication of future development of the Founder Societies (ASCE, AIME, ASME, and AIEE) and the success that may be expected from programs initiated to bring about the long-desired unification of the profession.

The Smith Resolution

The Smith Resolution proposed in May, 1949, declares that the AIEE finds itself in an equivocal position, particularly in the eyes of the younger members, because it is attempting with inadequate funds and personnel to concern itself with the nontechnical interests of its members. It further states that nontechnical phases of professional interest may best be handled by some other organization established for that purpose, and concludes with the declaration that the AIEE is strictly a scientific and educational organization whose policy should be "to promote in every way the technical interests of its members to the exclusion of any other interest" and "to interest itself in only such joint matters as relate to the technical activities of its members."

It is understood that the resolution was drafted and submitted to create a clear-cut issue on which AIEE members could express themselves and thereby promote the movement for creation of an over-all society of engineers.

In receiving the resolution, the board of directors created a special subcommittee to undertake study of it and asked for a report for its meeting late in January, 1950.

The October Ballot

Following extensive preliminary discussion by the AIEE leadership at the general summer meeting in June, 1949, it was determined to submit the question posed by the resolution to the entire membership in the form of a ballot published in the October issue of *Electrical Engineering*. Members were asked to vote on one of two policy statements: (1) I favor adhering to technical field; (2) I favor expanding in nontechnical field with substantially increased dues. The ballots are to be mailed to section officers who will submit returns in time for the January meeting. In the meantime special meetings are being held in all sections before which AIEE officers are appearing to clarify issues.

Three questions are especially pertinent to the Smith Resolution and these have been commented upon by the special subcommittee of which M. D. Hooven, Public Service and Gas Company, Newark, N. J., is chairman, in the October issue of *Electrical Engineering*. These are: (1) What is meant by nontechnical activities? (2) Can the AIEE be really effective in such activities? and (3) What would be the cost of undertaking such activities?

Nontechnical Activities

The subcommittee feels that nontechnical activities of interest to electrical engineers cover a tremendous range. Among those most frequently mentioned in the discussions have been projects which aim: (1) To increase the prestige of engineers, with the work of the American Medical Association and the American Bar Association cited as examples; (2) to encourage legislation favorable to engineers in connection with registration; (3) to encourage participation by the Institute in civic affairs and to offer aid to governing bodies concerning public works; and (4) to improve labor relations and rates of compensation, a point of particular interest to younger engineers.

Can the AIEE Be Effective?

The subcommittee feels that the answer to the second question is "yes" provided sufficient time, money, and effort are expended. That the AIEE has done so well in the technical field is no reason to believe reasonable success cannot be achieved in other activities it undertakes. Many difficulties, however, are recognized. First among these is the diversity of professional status of its members. Some are employees, some have supervisory positions, while others are themselves employers or self-employed. While these interests have a common ground in technology, no unanimity can be expected on social, economic, or political questions. Secondly, to be effective the Institute would have to organize both a new staff and new committee structure which would be obliged to work closely with other engineering bodies operating in the nontechnical field.

How Much Would It Cost?

At this preliminary stage before specific projects have crystallized no one knows, the subcommittee feels, what the cost would be. Practically, however, the Institute would have to tailor its activities to the ability of members to pay more dues. For purposes of speculation, an increase of annual dues by $15 was mentioned. Such an increase could provide a quarter of a million dollars which probably could pay for a new staff about the size of the present one with enough remaining to support the work of new section and national committees.

AIEE 1946 Poll

While the form of the ballot has met with some criticism on the point of ambiguity, AIEE members are acutely aware of the issues and the implications of any opinion they may express. The discussions fortunately are being carried on against a background of experience provided by the AIEE poll of 1946–1947 which stimulated society-wide investigation into the kind of organizational structure which would best meet the needs of a unified engineering profession. At that time four different plans for organizing the engineering profession were proposed. Details of each plan were worked up on placards and these were subjects of discussion at local meetings, following which members registered their preferences. While none of the schemes received a clear majority, Plan D, which proposed a new American Society of Engineers with existing societies as technical divisions, was favored by more than 40 per cent of those voting.

Preliminary comment on the Smith resolution by AIEE leadership substantiated a strong desire among electrical engineers for unification of the profession along the lines of Plan D. What was not clear, however, was what policy the Institute should follow in the interim period before unification can be achieved. The October ballot was framed to provide an answer to this question.

Engineers Can Co-Operate

James F. Fairman, president AIEE, has long been an advocate of unification. He believes deeply that engineers can "be persuaded to pull together, to co-operate, to pool their talents and resources in an orderly organized effort to attain common objectives outside their several fields of specialized technology."

Last year he served as a vice-president of The National Society of Professional Engineers.

In a recent discussion published in *Electrical Engineering*, Mr. Fairman said, "If we adopt the Smith Resolution or its substantial equivalent, we shall confine our work as an organization to the field of electrical-engineering technology . . . . No change of organization will be involved. There will be no requirement for increased income to cover new services and activities. The Institute will continue to be what it has primarily been since its founding. Our members who are interested in the nontechnological problems will have to turn to other organizations . . . ."

On the other hand, he continued, if the members vote to expand services and activities to include the nontechnological problems of the engineer, the Institute will have to augment the staff and committee structure either separately or jointly with other like-minded societies or both, to carry on this new work. Additional income will be required as the work expands. The Institute will become a somewhat different organization.

"Our members who are interested in the nontechnological problems of the engineering profession," he said, "will not have to turn to other organizations for the handling of those problems."

Exploratory Conference Held On Unity of Profession

14 Engineering Societies Participate

FOR some time the Engineers Joint Council has been studying suggestions which have been made from various sources as to means by which the engineering organizations of the country could co-operate in increasing the unity of the engineering profession. These studies led to an invitation sent this past summer by Engineers Joint Council to 16 of the leading engineering societies of the country, suggesting that each society designate a representative to take part in an exploratory meeting to discuss further this important subject.

This meeting was held at the Engineers' Club, New York, N. Y., Oct. 20, 1949. Representatives of 14 of the 16 societies were present and there was a full and free discussion of the whole problem.

There was general agreement among the members of the group that some steps looking toward organizing for increased unity of the engineering profession would be desirable. If an organization is to speak for the profession as a whole, it should have a structure which would enable it to respond to the various services which it may perform. No conclusion was reached as to the form which such structure might take. However, the group felt that the first approach to this subject would best be made through considering methods for closer co-operation between the existing organizations and for modifying, and perhaps grouping, some of these organizations rather than to consider the establishment of an entirely new additional organization.

As a result of the discussion a Planning Committee was appointed from members of the group, charged with the responsibility for preparing statements regarding various alternative plans of achieving this aim and reporting back to the main group. The date of the next meeting of the main group was set tentatively for Jan. 27, 1950.

Representatives of the various engineering groups attending the Exploratory Meeting on unity were:

American Association of Engineers, James H. Griffin, Board of Transportation of City of N. Y., New York, N. Y.

American Institute of Chemical Engineers, L. W. Bass, U. S. Industrial Chemicals, Inc., New York, N. Y.

American Institute of Electrical Engineers, T. G. LeClair, Commonwealth Edison Company, Chicago, Ill.

American Institute of Mining and Metallurgical Engineers, James L. Head, Anaconda Copper Company, New York, N. Y.

American Society of Civil Engineers, Carlton S. Proctor, New York, N. Y.

American Society for Engineering Education, Dean Thorndike Saville, New York University, New York, N. Y.

The American Society of Mechanical Engineers, Edgar J. Kates, New York, N. Y.

American Society of Refrigeration Engineers, Burgess H. Jennings (part time), Northwestern University, Evanston, Ill.; (alternate) during Professor Jennings' absence—C. F. Kayan, Columbia University, New York, N. Y.

American Water Works Association, Harry E. Jordan, American Water Works Association, New York, N. Y.

Institute of Aeronautical Sciences, S. Paul Johnston, Institute of Aeronautical Sciences, New York, N. Y.

Institute of Radio Engineers, B. E. Shackelford, RCA International Division, New York, N. Y.

National Society of Professional Engineers, Alex Van Praag, Jr., Warren and Van Praag, Inc., Decatur, Ill.

Society of Automotive Engineers, Hollister Moore (alternate for W. S. James), Society of Automotive Engineers, New York, N. Y.

Society of Naval Architects and Marine Engineers, J. H. King (part time), Babcock and Wilcox, New York, N. Y.; alternate during Mr King's absence, Captain W. N. Landers, Society of Naval Architects and Marine Engineers, New York, N. Y.

Members not present were: *American Society of Heating and Ventilating Engineers*, Dean L. E. Seeley, University of New Hampshire, Durham, N. H.; *Illuminating Engineering Society*, Lee E. Taylor, The Detroit Edison Company, Detroit, Mich.

Members appointed to the Planning Committee are: B. E. Shackelford, IRE, chairman; L. W. Bass, AIChE; Edgar J. Kates, ASME; T. G. LeClair, AIEE; Dean Thorndike Saville, ASEE; Alex Van Pragg, Jr., NSPE; R. E. Dougherty, EJC; H. S. Osborne, secretary.

Mr. Osborne is chairman of the EJC Committee on Unity of the Engineering Profession.

President Truman Addresses Engineers on His Point Four Program

PRESIDENT Harry S. Truman in a jovial impromptu speech before the Fall Meeting of the American Society of Civil Engineers in Washington, D. C., Nov. 2–4, 1949, stumped to win support of engineers for his "Point Four proposition" and suggested that the Engineers Joint Council project for appointment of engineers to administrative posts in the U. S. State Department might soon meet with success.

"Nearly every operation of the Government of the United States at one stage or another requires engineering skill and knowledge," President Truman said. Noting that even the legal phases of Government sometimes needed engineers for expert purposes, he added, "And if I have my way, the Department of State will get some engineers before we get through."

His main purpose, however, was to appeal for support for "another proposition which I am vitally interested in and that is the so-called Point Four." In his inaugural address, in January, 1949, he had declared that the nation "must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas." (The full text of Point Four statement appears on page 354 of the April, 1949, issue of MECHANICAL ENGINEERING.)

Mr. Truman continued: "And I think this great nation of ours is more nearly equipped to do that sort of job than any other nation in the world.

"There is a struggle now going on between two ideologies. One of those ideologies is backed by a moral code, and one is backed by no moral code.

"My ambition is to show that that ideology backed by a moral code can do the best for the people of the world. I am just as sure of that as I stand here.

"And I hope that all the engineers of this great United States of ours and all the other great technical men—the architects, the physicians—everybody who has a special skill for the welfare of humanity—will inform himself on just exactly what I mean by Point Four.

"It will mean: If we can make a contribution in the know-how and raise the standard of living just two per cent in the rest of the world, our factories and our businesses never could catch up with the demand that would be on them. Just think of that! That's all we need to do. It is not beyond the bounds of possibility. There are resources in this great world that never have been touched. There

are resources in Africa, in South America, in Asia—the most wonderful resources that the world can produce.

"And if those resources produce things for the welfare of the people of the world, to keep the world from being hungry, then no one would have any idea of carrying on a destructive war for the purpose of obtaining something that didn't belong to them. That's what the cause of wars has been. It has been the idea of grasping something that the other fellow has.

"Now, let's try to make the other fellow as contented as we can be, by helping him develop his resources for his own welfare and benefit. And when he does that, he is going to need so many things that we produce to give to him, that we never will catch up with the demand."

Mr. Truman urged engineers to "begin to think about world-wide plans, city-wide plans, county-wide plans, state-wide plans, and plans for the great United States of America, and plans for the whole world that will make everyone in it happy and contented." Referring to the growing population of the United States, he said the next census would show a population of 150 million. "It is our business," he said, "to anticipate at least a population of 300 million in the next 100 or 150 years. Maybe it won't take that long."

President Truman told of a Government engineer who once reported that if a bridge were built across the river at St. Louis, the thriving village of 300 was sure to grow within 50 years to a town of 1500 people. "Well," the President continued, "they built that bridge and St. Louis has got a million people in it. The engineer didn't quite have his sights high enough. You can't get them too high."

Industry and the Engineer

INDUSTRY as the habitat of the engineer was the general theme of four speeches delivered at the convocation held Oct. 4, 1949, to mark the 125th anniversary of the founding of Rensselaer Polytechnic Institute, Troy, N. Y., the first school in the United States established expressly for the purpose of "lifting the application of science from the rule of thumb of the artisan to the mobile hands of a skilled profession."

Industry expects of the engineer, achievement, orderly thinking, and vision not only in the sphere of technology but also in that of human relations, according to Charles E. Wilson, Mem. ASME, president, General Electric Company, Schenectady, N. Y.

What Is Industry?

In defining what industry meant to him Mr. Wilson said, "It is labor, it is management, it is research and engineering, it is investment, and it is sales. To some degree it is just about everybody you know—and not just a small, selfish, rich, and aged group of Republicans. The hard and constant fight for every one of us who believes that what happens to America, and by the same token what happens to the world, must be a direct result of the efficiency and productiveness and leadership of our own competitive economy, consists of this day-by-day campaign to teach our people that industry is not a political party, that it is not a special interest, that it is not an antisocial force. Rather it is the organized striving of millions of our fellow citizens, the harnessing of their brain power and their labor, the mustering of their needs and desires, the enrollment of their ambition and their accountability, to the end that they will be better fed, better housed, better secured against disaster, better informed, and inspired by a true respect for their own powers and their own dignity. That is industry, and to me that is not a visionary or fuzzy description, but a down-to-earth practical description."

The purpose of industry today, he continued, transcends its purpose to make money. Aware of its social responsibilities it strives to make money in order that it may continue in business to protect the personal property of stockholders and jobs of employees.

While industry must depend on "scientific research, fine engineering, precision manufacturing and wasteless distribution," the ultimate key to its well-being and progress is "the individual human being—the economic, social, political being."

Bigness in Industry

Speaking on industry's responsibility to the future, Eugene Holman, president, Standard Oil Company of New Jersey, commented on the question of bigness in industry. He said, "The kind of output needed in today's world calls for organization on a big scale—for big companies. Today, we hear much said about bigness in industry. Many people seem to be afraid of it. Actually bigness in industry is what has made mass production and mass distribution possible. In a free country, bigness is simply a technique for achieving results—big results.

"The existence of big companies certainly does not hinder the entrance of new enterprises. The records of the Department of Commerce show that many hundreds of thousands of new businesses have been established since the war.

"Large-scale operations are a legitimate and healthy child of our times. Bigness in organization is no more strange or dangerous than bigness in equipment and machines. Big machines, big operations, and big organizations are related—and they are prime products of our high standards of living."

Engineering has an important role as the creator of new industries, according to Amory Houghton, chairman of the board, The Corning Glass Works.

He suggested two directions in which engineering might advance in the future; the development of new materials and new sources of power. As possible sources of new materials he suggested, "synthetic combinations of common substances, and the growing of raw materials on farms and in the vast reaches of the ocean." For new power the potentialities of wind, tides, and the sun ought to be explored.

Human Relations

Hiland G. Batcheller, president, Allegheny Ludlum Steel Corporation, speaking on "The Engineer in Human Relations" told what engineers could do to promote amicable relations with workers in industry.

"The first is to keep their slide rules well hidden. The second is to treat engineering not as a thing of mystery, but as the skillful application of knowledge and common sense. As part of this process, the engineers might trade some of their technical terms for a few simple layman's explanations. If they will do this, they will suddenly find themselves winning a lot more friends and influencing more people.

"The young engineer should be particularly careful not to look down his nose at the man without formal technical training. Some of our most important discoveries have been made by men who didn't know what the book said or didn't care. They trusted their own observations and followed their own intuition."

Vannevar Bush Warns Against Danger of the Welfare State

THERE is a need to "temper humanitarianism with hard common sense" if national security is not to be impaired by the social and economic trends implied in the term "the welfare state."

This point was made recently by Vannevar Bush, president, Carnegie Institute, at the convocation ceremonies marking the 90th anniversary of the Cooper Union for the Advancement of Science and Art, New York, N. Y.

Commenting on the welfare state type of personal security as an engineer and man of science, Dr. Bush warned that if the spirit of individual risk taking is smothered in the search for artificial security and in over-regulation, there was a danger in reversing the "virile" trend which had made America great. "The dangers of rushing into a welfare state are very practical and very immediate."

Overdoing Secrecy

Security is a good thing, he said, but if it is carried too far it could defeat its own purpose. Referring to the military phases of security, Dr. Bush warned that in the light of the Russian success with the atomic bomb, overdoing the secrecy of scientific information could hamper industrial development needed for national security.

"This is not merely a question of weapons, or armies, or appropriations. It is a question of whether the country as a whole is healthy,

with a strong vigorous successful independent industry, with a soundly balanced budget, and an unimpaired national credit, with progress on every front by pioneers and innovators.

"If we build well we can have security, genuine national security. But if we are deluded into believing that security of the individual against all hazards and all ills can be obtained by fiat and by law, without limit, and without deliberate progress toward an end, we will sacrifice the foundations which make humanitarianism possible, and start the weary climb over again, only after a long dark interval.

"The danger of a central bureaucracy, which plans all our lives and doles out what it thinks we need, is much more than that it will plan badly, although it undoubtedly will. The greater danger is to ourselves, that we will cease to think for ourselves, that we will not exert ourselves when only a drab mediocrity lies ahead, that we will substitute the arts of petty political maneuvering for virile self-reliance."

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"If we want a system in which, by every artifice we can command, we protect the individual citizen against all the ills of nature and of grasping man, we can have it.

"On the other hand, if we want the kind of country that has thus far prospered well, if the youth of our land wish adventure and the conquest of new horizons, great possibilities lie before us. The application of science has much yet to offer, and a strong country can maintain our national security and give us opportunity to develop our great potentiality."

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"Throughout all of the international discussions, we observed how closely our basic problems parallel those of other countries," said W. H. Gourlie, standards engineer, The Sheffield Corporation, reporting on the international consideration of a problem of fundamental importance to the machine industry—that of limits and fits between cylindrical parts.

A similar theme was presented by Joseph P. Greenwald, economist with the International Resources Division, U. S. Department of State.

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Founder Societies Face Housing Problem

Engineering Societies Building too Small

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The question of what to do about the building has been before the United Engineering Trustees Inc., operating organization of the Founder Societies for several decades. Numerous surveys and studies have been made by real-estate experts, without terminating in action because either times or circumstances were not favorable.

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The functional obsolescence is most pronounced in the limited space which no longer is adequate for the purposes of the Founder Societies. The AIEE and the ASME have been forced to rent space in nearby buildings to house their editorial staffs. National meetings of the engineering groups long have outgrown the limited facilities of the first-floor lobby, meeting rooms, and the engineering auditorium, and these groups have been forced to use public rooms of hotels for the housing of these functions. The Engineering Societies Library is woefully short of space and some provisions must be made immediately for housing the expanding engineering literature.

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Another problem is the "extremely bad condition" of the windows. Stop-gap repairs have been made in the past few years but the day cannot be delayed much longer when general refenestration will be required. The cost of this work might be higher than estimated if, upon removal of the window frames, extensive wall or other repairs are required.

If the study now under way uncovers no offers for purchase or trade of the building, it is expected that the UET will embark on a 5-year program of rehabilitation which at best can put off the day when the American engineering profession will be faced again with the problem of a new national home.

Methods for International Co-Operation Discussed by EJC Committee

Informal Relations Favored

COLLABORATION among the professional engineering societies of the world can best be achieved by easy stages beginning with the formation of a federation of the Societies on the policy-making level based on mutual agreement on a simple statement of principles, but without formal constitution, different grades of membership, full-time secretariat, or regular dues.

This was the consensus of the Committee on International Relations of the Engineers Joint Council which met in the Engineering Societies Building, New York, N. Y., Oct. 26, 1949, to discuss the reports of EJC representatives to the London Conference, held in London in September, 1949, and the First Pan-American Engineering Congress held in Rio de Janeiro, July, 1949.

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Recommendations

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whose organization, reorganization, consolidations, and discontinuance are placed at the discretion of the President, the Secretary of Defense, and the Secretary of War.

The purpose of the new legislation is "to provide for Army flexibility, for centralization of authority and responsibility, for improving functional operations and for a better statutory base than now exists," but if passed the bills would achieve flexibility to the extent of demoralization, particularly in so far as engineers and scientists are concerned, in Colonel Carey's opinion.

The proposed bills could destroy the Army technical services by undermining the sustained interest of civilian professional engineers so essential to Army success in war and in the preparation of war. Without statutory safeguards, the policies and existence of the technical services are exposed to the "inept, capricious, politically activated, or otherwise dictated" decisions of one elected officer and two administrative appointees, who cannot be expected to be professional engineers.

Professional Status for Engineers Denied

"The drafters of this legislation," Colonel Carey states, "apparently have completely disregarded the importance of engineers and scientists in the Army. Professional status of engineers is implicitly denied in this bill, but it is sustained and maintained for the professions of medicine, law, and theology. Engineers generally will favor statutory protection for the professional status of men in these 'special branches,' but to deny similar professional status to engineers and scientists denies many bitter lessons of World War II experience. (See pages 263–264, March, 1949, issue of MECHANICAL ENGINEERING.)

"The technical and professional requirements for competence in engineering research, design, and development are no whit less technologically demanding than the professional requirements of men in the 'special branches' prescribed.

"Should the proposed legislation be enacted, leaving no statutory provisions to maintain and improve the professional status of engineers and scientists in the Army, it is most unlikely that these civilian components will long hold many engineers now enrolled.

The uncertainty and confusion which would face such men under the proposed legislation will surely discourage civilian engineers and scientists from joining these civilian components. Essential development of the civilian components of the Army, as to engineers and scientists, will be made a more difficult, if not an impossible task, if this bill passes."

British Designers' Society Enters Fifth Year

THE Institution of Engineering Draughtsmen and Designers, organized in 1945 to promote the professional interests of British draftsmen and designers, recently published its fifth edition of general information about the organization.

According to *Engineering* (Sept. 16, 1949) the Institution has three main objectives: (1) To promote the general advancement of the science of engineering design and to forward the practice and standardization of mechanical draftsmanship; (2) to serve industry and the community by furthering the utilization of two and three-dimensional drawing technique; and (3) to raise the status of the profession of engineering draftsmen and designers.

Admission to membership is by examinations involving a test of theoretical knowledge, assessment of the candidate's professional ability, and a scrutiny of his integrity. There are four grades of membership: fellow, member, associate member, and student.

The Institution has 20 branches in British industrial centers.

ESL Announces New Service Plan

THE comprehensive service plan was recently instituted by the Engineering Societies Library, New York, N. Y., to eliminate the difficulty, inconvenience, and time-consuming effort of locating published articles and to get photoprints from other libraries. The plan is designed to enable the engineer to send all his orders for photoprints to one place.

Comprehensive Service

A photoprint copy of any engineering or technical article that is available anywhere in this country, whether or not in this library, will be supplied at a flat rate of $5 per article, if the article is not over 25 pages. For longer articles there will be an additional charge of $2.50 for each 25 pages or fraction thereof.

The Comprehensive Service will be furnished only to those organizations and individuals who agree, in writing, to accept the conditions and rates of the Comprehensive Service plan as the basis for all photoprint orders placed by them with the Engineering Societies Library from the date of agreement, for a trial period, through Dec. 31, 1950. If this experiment in greater service to engineers proves practicable, agreements may be renewed. For copies of the agreement forms, write to the ESL, 29 West 39th St., New York 18, N. Y.

Limited Service

Only material in Engineering Societies Library is copied under the Limited Service plan. As in the past, this service is available without a signed agreement. Photoprints will be supplied for 40 cents a print—minimum charge $1 per order. Any two facing pages that together measure not over 11 × 14 in. can be taken on one print. Larger material will require one print per page.

Charges to ASME Members

Members of ASME who order photoprints for their personal use will be charged $4.50 and $2 instead of $5 and $2.50 for the Comprehensive Service. For Limited Service the charge will be 35 cents a print instead of 40 cents.

The photoprints will be white on black (negative) prints. As some will be obtained from other libraries, the sizes may vary.

Copyrighted material will not be copied beyond recognized "fair use" without the signed authorization of the copyright owner. All responsibility for questions of copyright that may arise in the copying and in the use made of the copies must be assumed by the applicant.

Rates are subject to change without notice, except that no increase will be made without notifying those having effective agreements for the use of the Comprehensive Service.

Mechanical Engineering Societies Discuss Co-Operation

AT the invitation of James M. Todd, president of The American Society of Mechanical Engineers, a meeting of presidents and secretaries of the American Society of Heating and Ventilating Engineers, the American Society of Refrigerating Engineers, and the ASME, was held in the Engineering Societies Building, New York, N. Y., Oct. 26, 1949. A. E. Stacey, Jr., Burgess H. Jennings, and James M. Todd, presidents; and A. V. Hutchinson, M. C. Turpin, and C. E. Davies, secretaries, respectively, were present.

The question of co-operation between the three societies was reviewed with the general conclusion that each society should encourage its local Sections to co-operate more closely in local meetings and activities of the sections of the other two societies. It was also agreed that the members of the staffs of the three societies concerned with meetings and publications should meet in the relatively near future and that after these meetings had been held and an opportunity given to review the experiences of joint section meetings, a further meeting of presidents and secretaries would be held, this time at the call of the officers of the American Society of Heating and Ventilating Engineers.

Full Membership Status Denied to Women by Tau Beta Pi

THREE attempts to change the constitution of the Tau Beta Pi Association to permit admittance of women to full membership were defeated at the 44th convention of the Association held at Purdue University, West Lafayette, Ind., Oct. 13–15, 1949. The first was a simple motion to make women eligible for full membership on the same basis as men; the second was an alternate motion of permitting the undergraduate chapters to elect women to full membership or to award the present Women's Badge at the chapter's option; and third was a motion to direct the Association's executive council to submit to the chapters the constitutional changes necessary to accomplish the optional election of women by chapters who might wish to do so.

Tau Beta Pi chapters now have the right to award the Women's Badge to outstanding women in engineering. Ninety-six women have been so honored in the past 25 years for their undergraduate work and one for attainments in the professional engineering field.

Codes and Standards

1950 Edition of Unfired Pressure Vessel Code Published by ASME

Higher Unit Stresses Allowed

RECENT publication of the 1950 edition of the "Rules for Construction of Unfired Pressure Vessels, Section VIII of the ASME Boiler Construction Code,"[1] by The American Society of Mechanical Engineers brought to a head over 12 years of effort on the part of a special committee of engineers appointed by the Boiler Code Committee in 1936. The committee was originally organized under the chairmanship of E. R. Fish, at that time chairman of its Subcommittee on Unfired Pressure Vessels. Its first meeting was held on Nov. 20, 1936.

The need for the new code grew out of a demand in 1935 for more consistent up-to-date rules of procedure for the construction of unfired pressure vessels, to replace the current issue of Section VIII, with the ultimate aim of having a single code for such vessels that would gain general acceptance by the representatives of many industries.

The committee's principal aim was to consolidate the best of all existing rules for unfired pressure vessels in order to obtain more uniformity in construction procedure and enforcement under uniformly safe laws. The confusion attendant to having rules in different states that were not in full agreement on basic rules and particularly in which the inspection requirements were different, not only caused extra burden to the manufacturers and users, but also, in many cases, seemed to add no intrinsic safety to any vessel during its operation.

During the 12 years that the 1950 edition came into being, the technological problems involved in the design and construction of pressure vessels increased greatly. The onset of World War II naturally delayed the committee's work, while at the same time research and development increased new uses for pressure vessels, demanding extreme temperatures and pressures beyond even the range of most steam-boiler designs. The metallurgical knowledge required of a designer of the more complex unfired pressure vessels now should properly be supported by the knowledge of the metallurgist or a metallurgical engineer.

[1] Copies may be obtained from ASME Publications-Sales, 29 West 39th Street, New York 18, N. Y. Price per copy is $3.50.

Higher Unit Stresses Allowed

One of the most important factors in the development of these more modern rules was the full recognition that, with the present knowledge of materials and fabrication and the improved results obtained by modern inspection methods, a higher unit stress could safely be adopted for all grades of steel. Many of the principal experiences concerning higher stresses were had in the petroleum and chemical industries, using the design stresses in Table 1 of the API-ASME Code which were 1.25 times the figures permissible in the ASME Code, Section VIII, and up to a temperature of 650 F. Above this temperature, there are some higher or lower figures within the creep range of steels and the differences here are now in the process of adjustment. The latter may affect the figures now in Table UG-23 of the 1950 edition.

Progress was made in the efficiency ratings for welded joints by changing the present limitations in ASME Section VIII to conform closely to similar factors for welded joint efficiency given in the API-ASME Code. This provides a greater degree of refinement in the grading of these factors, particularly as regards stress-relieving.

While these principles of aiming for uniformity and the inclusion of latest developments have been followed as far as practicable, there are still known to be some differences and omissions in the 1950 edition. Most of these are recognized in a footnote to the Preamble, as follows: Parts UF, requirements for integrally forged vessels; and UB requirements for brazed vessels have not yet been prepared. Also in preparation are Parts UHA, UCI, UCL, and UNF covering requirements for high-alloy, cast-iron, clad, and nonferrous vessels, respectively.

These parts are now being written up and will be added as soon as completed, possibly as a supplement to the 1950 edition.

Supplementary Rules Enlarged

The Appendix for supplementary rules of design and data as now in current Section VIII, has been enlarged particularly for design of thick and thin shells and heads of larger vessels where greater exactness permits worth-while economies.

One new departure of the 1950 edition are the number of nonmandatory appendixes. Appendix X includes a recommended practice for the inspection, repair, and allowable working pressures for vessels in service patterned after a similar section in the API-ASME Code. Where corrosion is expected to any degree this has particular significance. Nonmandatory appendixes are listed in this code to recognize that the engineer's judgment must always be a large part of his responsibility for the use-life of the vessel. They are intended to supply information to both the designer and inspector which could not be properly part of construction rules.

To clarify the situation as to jurisdiction and official standing for the 1950 edition, as compared to previous issues of Section VIII, it is specifically stated in the Preamble of the former: "As the date at which these new Code rules may become effective for use in the several administrative jurisdictions may vary, it is suggested that manufacturers and interested parties consult with such jurisdictions."

Pending the adoption of the rules when completed, or together with the presently recognized issue of Section VIII and such case interpretations as apply, the latter may be supplemented by the rules in the 1950 edition which are agreed upon by the responsible authorized inspector.

It is the firm hope of those who have devoted much of their efforts in the compilation of this new code in its present form, that it may be adopted without material changes by regulatory bodies responsible for the enforcement of laws concerning pressure vessels, by the insurance agencies, and particularly by the industries to which the construction and use of pressure vessels are an important factor in their business.

In the preparation of the 1950 edition of Section VIII, the special committee was ably assisted by many other subcommittees of the ASME Boiler Code Committee and by individual engineers. There will continue to be a need for such help as no code can be complete at any one date, as it must be kept in step with new developments.

(By WALTER SAMANS, chairman, Subcommittee on Unfired Pressure Vessels, ASME Boiler Code Committee)

Plain Washers

THE following American standards were recently published by The American Society of Mechanical Engineers. Copies may be obtained from ASME Publication Sales, 29 West 39th Street, New York, N. Y.

PLAIN Washers, ASA B27.2-1949. This is a new standards work on which was begun in 1928 by a subcommittee of the American Standards Association Sectional Committee B27, sponsored by The American Society of Mechanical Engineers and the Society of Automotive Engineers. The document lists plain washers in four classes: light, medium, heavy, and extra heavy with inside diameters ranging from $^{5}/_{64}$ to $3^{1}/_{8}$ inches.

Price per copy is 25 cents.

Stainless Steel Pipe

STAINLESS Steel Pipe, ASA B36.19-1949, sponsored by The American Society of Mechanical Engineers and the American Society for Testing Materials. The document lists outside diameters and nominal wall thickness as well as two nominal weight tables. Table 1 lists the outside diameters and nominal wall thickness of schedules 10S, 40S and 80S for nominal pipe sizes ranging from $^{1}/_{8}$ to 12 inches. Table two lists nominal weights of carbon-steel pipe covering the same sizes and schedules.

The standard was published because "more recent developments of the highly alloyed stainless steels have brought about a minor conflict with convention. With these newer materials, the need for standards is just as great and the present types of threads are just as satisfactory, but the basic cost of the metal is much higher and the art of fusion-welding has developed concurrently. The character of stainless steel permits the design of thin-wall piping systems without fear of early failure due to corrosion, the use of fusion welding to join such piping has eliminated the necessity of threading it. For these reasons, the wall-thickness dimensions shown under Schedule 10S have been developed, based on the conventional formula but then modified to correspond to the nearest Birmingham wire gage (B.W.G.) number." Price per copy is 30 cents.

Graphical Symbols

GRAPHICAL Symbols for Welding, ASA Z32.2.1-1949. This 72-page standard covers welding symbols and instructions for their use. The symbols were developed by the American Welding Society from those used in the United States and abroad. The standard is one of several which will replace the symbols on welding given in the appendix of the American Standards, Z32.2-1941 and Z32.1-1942. Price per copy is 50 cents.

* * *

GRAPHICAL Symbols for Pipe Fittings, Valves and Piping, ASA Z32.2.3-1949. The symbols in this 11-page standard are those agreed upon by more than 100 companies whose representatives were consulted in formulating it. Great care was exercised to avoid conflicts with the symbols being assembled by committees in allied fields. The 73-symbols shown are a minimum requirement. Many other piping symbols exist, for example, those used in petroleum piping. The purpose of the standard is to provide architects, engineers, and contractors with standard symbols to use on drawings in order to prevent confusion in the interpretation of requirements. Price per copy is 40 cents.

* * *

GRAPHICAL Symbols for Heating, Ventilating, and Air Conditioning, ASA Z32.2.4-1949. This shows 81 symbols for use on drawings covering elements of heating, ventilating, and air-conditioning systems. It is one of the group which will ultimately replace the present American Standard Graphical Symbols for Use on Drawings on Mechanical Engineering, Z32.2-1941. The symbols were the minimum requirements agreed upon by representatives of 150 companies.

Price per copy is 40 cents.

Notes on Coming Meetings

Plastics

THE National Society of Plastics Engineers will hold its 1950 conference at the Hotel Carter, Cleveland, Ohio, Jan. 11–13, 1950. Plastics experts from the United States, Canada, and Mexico are expected to attend.

The conference will feature presentation of twenty papers on original research in the plastics industry. Discussions will cover new developments and techniques in manufacturing plastics as well as new uses.

The Society of Plastics Engineers, organized in December, 1941, emphasizes the work of the individual scientist, rather than the company he represents; it encourages original work in engineering research and the preparation of original papers; and it promotes the development of engineering standards and publishes technical data of value to plastics engineers.

Air Pollution

THE 30th anniversary meeting of the American Meteorological Society to be held in St. Louis, Mo., Jan. 3–6, 1950, will feature an air-pollution symposium. The symposium will consist of two main parts. One part will be a panel discussion by leading national authorities on the different phases of air-pollution abatement, such as enforcement, public health, equipment, industrial, and research.

The second phase of the symposium will be a series of technical papers. These have been selected to emphasize the meteorological and climatological phases of air pollution and will cover subjects such as: urban diffusion of smokes, forecasting atmospheric dispersion conditions, dispersion from stacks, climate influences on pollution, and the like.

For further information concerning the symposium contact national headquarters of the American Meteorological Society, 5 Joy Street, Boston 8, Mass.

Plant Maintenance

A GROUP of 21 experts will lead a discussion of plant-maintenance problems at a conference to be held concurrently with the Plant Maintenance Show, at the Auditorium, Cleveland, Ohio, Jan. 16–19, 1950. L. C. Morrow, Mem. ASME, co-editor, *Factory Management and Maintenance*, will act as chairman of the conference, which is being sponsored by The American Society of Mechanical Engineers and the Society for the Advancement of Management.

Topics for the four-day conference include maintenance-management principles; maintenance cost; light equipment; upkeep of motors; controls; distribution equipment; floors, walls and roofs; use of electrical instruments in maintenance; relationship of color and light to production; sanitation, lubrication; use of service equipment, and personnel safety.

The Cleveland Engineering Society will sponsor a dinner for guests.

Fluid Dynamics

MIDWESTERN conference on fluid dynamics under the sponsorship of The American Society of Mechanical Engineers and several other societies will be held at the University of Illinois on May 5–6, 1950. The sections on mechanical engineering (power plants, turbines, jets) and aerodynamics will be composed of contributed and a few invited papers from the Midwestern area. Information regarding the papers may be obtained from chairmen of the sections: Dr. H. Korst, 166 New Mechanical Engineering Building (power plants, turbines, jets, compressors, etc.) and Prof. M. Z. V. Krzywoblocki, 107 Transportation Bldg., University of Illinois, Urbana, Ill. (aerodynamics, compressible flow, and gas dynamics).

General information may be obtained from the general secretary of the conference, Professor Krzywoblocki. The authors who intend to contribute papers are requested to contact the chairmen of the sections at their earliest convenience.

Scientific Management

THE NINTH International Management Congress to be sponsored by the International Committee for Scientific Management (CIOS), will be held at Brussels, Belgium, during the first two weeks of July, 1951. The program will consist of one opening general session, 12 working sessions, one motion-picture presentation of work simplification, and one closing general session.

American participation is being organized by the National Management Council of which The American Society of Mechanical Engineers is one of the members.

United States management engineers have been assigned responsibility for three of the work sessions, during which progress will be reviewed in the following management techniques: Work measurement, advanced procedures in public administration, and education for management. The motion-picture demonstration of work simplification will also be a responsibility of American engineers. (See page 777, September, 1949, issue of MECHANICAL ENGINEERING.)

Education

COLUMBIA University, New York, N. Y., has taken the first steps toward acquisition of property near Riverside Drive, as a phase of its projected engineering center, it was announced recently by University officials.

The property under consideration includes a building owned by the Sheffield Farms Company and seven plots of land bordered by 125th Street, St. Clair Place, and Riverside Drive.

The building, originally designed for dairy-products processing, makes it adaptable for use in engineering operations requiring steam, water, refrigeration, sewer drainage, and related projects. Present plans call for its use for such activities as fluid mechanics and fluid-flow processes of both gases and liquids, heat transfer, refrigeration applications, process control, and other similar uses.

The purchase of the property represented the first step in a proposed $12,000,000 program for the school of engineering. The long-term objective includes construction of a six-story laboratory building at a cost of $5,000,000 as a main unit of the research center and an additional minimum endowment of $7,000,000 for physical operation, research fellowships, scholarships, and basic-engineering program.

A step opening the way for graduates of American schools of architecture to be admitted to the renowned French school of fine arts, the Ecole des Beaux-Arts, was announced recently by the American Institute of Architects.

Up to this time, graduates of American schools of architecture were admitted to the Ecole des Beaux-Arts only after a detailed qualification procedure. Under the new arrangement with the French school, worked out by Julian Clarence Levi, New York, N. Y., chairman of the Committee on International Relations of the AIA, selected graduates of American schools will be admitted by Beaux-Arts without examination.

In effect, the selected American architects will have the benefit of postgraduate study at the 300-year-old Paris institution at the expense of the French government, since the school is supported by the government and has no tuition fees. The new agreement reflects international recognition of the high standing of architectural education in the United States.

Ayer Hall, a new $500,000 college-of-engineering building, The University of Akron, Akron, Ohio, was dedicated Oct. 21, 1949, by holding open house, unveiling a portrait of Dean-Emeritus Frederic E. Ayer, and a dinner meeting at which Dr. A. A. Potter, Fellow ASME, dean of engineering, Purdue University, Lafayette, Ind., addressed educators, industrialists, and alumni. While the University is a municipal-tax-supported institution, the building was financed by donations from Akron industries and alumni. It is the second building to be completed under the present expansion program.

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WILLIAM R. CHAMBERS, Fellow ASME, was named head of the University of Tennessee department of mechanical engineering. Professor Chambers, whose appointment is effective immediately, succeeds the late Roscoe Morton, who had been a member of the ASME Council from 1943 to 1945, as head of the department.

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ESTABLISHMENT of the Milton Reynolds-Bill Odom Aeronautical Fellowship Fund at Stanford University, Stanford, Calif., was announced recently. The fund, which will set up five fellowships for young Stanford University aeronautical engineers, was begun with a contribution from Mr. Reynolds, internationally known pen and electronic-equipment manufacturer. A supplementary gift to the fund has been received from the Chicago Section of The American Society of Mechanical Engineers.

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TO STIMULATE interest in existing applications for cast stainless steel, and to encourage further advances in industry's constant battle against the ravages of corrosion, The Cooper Alloy Foundry Company, Hillside, N. J., announces that it will offer cash and prize awards totaling more than $5000 for the best technical papers submitted in accordance with the rules of its proposed essay contests. It is the present intention of the company in these contests to cover the major fields of application, including: chemical, food, textile, paper and pulp, aircraft, petroleum, and marine.

The chemical field has been selected for the first contest. Papers dealing with "Applications for Cast Stainless Steel in the Chemical Industry" will be accepted until May 1, 1950. Complete information concerning the contest and rules may be obtained by writing to the Contest Editor, The Cooper Alloy Foundry Company, Hillside, N. J.

Awards

WALTER HULL ALDRIDGE was elected to receive the John Fritz Medal for 1949, the highest award in the engineering profession. Mr. Aldridge has been president of the Texas Gulf Sulphur Company, New York, N. Y., for more than 30 years, is a trustee of Columbia University, and holder of the honorary degree of doctor of science and other honors.

The John Fritz Medal and certificate are presented not more often than once each year "for scientific or industrial achievement" in any field of pure or applied science. It was established in 1902 as a memorial to the great engineer and steelmaker whose name it bears, and is jointly sponsored by the Founder Societies of civil, mining, mechanical, and electrical engineers.

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EDWARD PEARSON WARNER, Mem. ASME, has been elected to receive the 1950 Daniel Guggenheim Medal and certificate. Dr. Warner is president of the Interim Council of Provisional International Civil Aviation Organization, Montreal, Quebec, Can., and has held many government posts in the aeronautical field.

The Daniel Guggenheim Medal was created for the purpose of honoring persons who make notable achievements in the advancement of aeronautics. Provision for the medal was made in 1928 by the gift from the Daniel Guggenheim Fund for the Promotion of Aeronautics. Some previous recipients of this medal are: Orville Wright, Boeing, Douglas, Martin, General Doolittle, Bell, and Grumman.

Meetings of Other Societies

December 4–7, 1949

The American Society of Refrigerating Engineers, 45th annual meeting, Edgewater Beach Hotel, Chicago, Ill.

December 8–10

National Society of Professional Engineers, annual meeting, Shamrock and Rice Hotels, Houston, Texas

December 19–21

American Society of Agricultural Engineers, winter meeting, Stevens Hotel, Chicago, Ill.

December 26–31

American Association for Advancement of Science, annual meeting, Pennsylvania Station zone hotels, New York, N. Y.

January 9–13, 1950

Society of Automotive Engineers, Inc., annual meeting and engineering display, Hotel Book-Cadillac, Detroit, Mich.

January 18–20

American Management Association, general management meeting, St. Francis Hotel, San Francisco, Calif.

January 18–20

American Society of Civil Engineers, annual meeting, Hotel Commodore, New York, N. Y.

January 23–26

American Society of Heating and Ventilating Engineers, 56th annual meeting, Hotels Adolphus and Baker, Dallas, Texas

January 23–26

Institute of the Aeronautical Sciences, 18th annual meeting, technical sessions, Hotel Astor, New York, N. Y.

January 30–February 3

American Institute of Electrical Engineers, winter meeting, Hotel Statler, New York, N. Y.

(*For Coming ASME Meetings see page 1075*)

ARTHUR C. SPURR, president of the Monongahela Power Company, Fairmount, W. Va., has been elected the 1949 Gantt Medalist. Mr. Spurr, public-utilities executive, has been president of Monongahela since 1935.

The Henry Laurence Gantt Memorial Gold Medal was established in 1929 to memorialize the distinguished achievements and great service to the community rendered by Henry Laurence Gantt, management engineer, industrial leader, and humanitarian. The award is made annually for "distinguished achievement in industrial management as a service to the community."

The medal is awarded by a board composed of representatives of the American Management Association and The American Society of Mechanical Engineers.

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HERBERT HOOVER, Honorary Member, ASME, was awarded the Frederick W. Taylor Key at the annual banquet of the Society for Advancement of Management at the Hotel Statler, New York, N. Y., Nov. 3, 1949. Mr. Hoover received the key for his services to the nation as chairman of the Commission on Organization of the Executive Branch of the Government, popularly known as the Hoover Commission.

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FRANK B. JEWETT, former president of the Bell Telephone Laboratories, will be awarded the Hoover Medal for 1949, one of the highest honors of the engineering profession. Dr. Jewett is a former president of the American Institute of Electrical Engineers.

The medal is awarded by the American Society of Chemical Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, and will be presented to Dr. Jewett at the Jan. 30–Feb. 2, 1950, general meeting of the AIEE in New York, N. Y.

He was recently named winner of the 1950 Medal of the Industrial Research Institute, Inc., at the closing session of the Institute's fall meeting, Oct. 12, 1949, in Chicago, Ill.

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THOMAS C. KAVANAGH, professor, civil engineering, Pennsylvania State College, won the $3000 first prize for design of a compact triangular-shaped steel frame to support the bridge roadway. The award was made by the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, as part of its award program. "Welded Bridges of the Future." Second prize of $1500 was received by Angel R. Lazaro, Jr., Malabon, Rizal, Republic of the Philippines; and third prize of $750 went to Fred C. Miller, consulting engineer, Toledo, Ohio. Ten honorable-mention awards of $100 each were also made for other outstanding bridge designs.

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WARD HARRISON, who retired in 1948 as director of engineering for General Electric Company, Nela Park, Cleveland, Ohio, received the Illuminating Engineering Society Medal, at the opening general session of the 1949 National Technical Conference of the IES.

HARVEY F. MACK, PRESIDENT, MACK PRINTING COMPANY, HONORED BY LAFAYETTE COLLEGE

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LYMAN C. FISHER, Mem. ASME, received the first Distinguished Civilian Service Award to be presented by the Secretary of the Navy at the U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Md., since the end of World War II. Associate chief of the Laboratory's mechanics research division, Mr. Fisher received the award for "extraordinary engineering ability, guidance, leadership, and executive competency" pertinent to the "reconstruction, renovation, and improvement of the Kochel (Bavaria) Supersonic Wind Tunnels" which are now in operation at White Oak.

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GEORGE W. CANNON, until recently board chairman of Campbell, Wyant, and Cannon, Muskegon, Mich., was honored by the Gray Iron Founders' Society, Inc., Cleveland, Ohio, for his outstanding contribution to the general welfare of the industry. He received the society's Gold Medal Award, at the 21st annual meeting which was held at the Edgewater Beach Hotel, Chicago, Ill., Oct. 28, 1949.

People

HARVEY F. MACK, president of the Mack Printing Company, Easton, Pa., was one of those honored by Lafayette College on Founders Day, Oct. 22, 1949. He received the degree of doctor of humane letters.

Dr. Mack is well known to engineers as the printer of scores of technical books and magazines, including the periodicals and Mechanical Catalog of The American Society of Mechanical Engineers. At the time Mack Printing Company was established, scientific and technical literature was confined largely to books which were produced at a cost beyond the means of the average man. Mr. Mack early recognized the need of the scientific fraternity for a publisher who could produce its literature at minimum cost, as well as the possibility of business growth and development with the needs of a growing engineering profession.

In 1945 the ASME expressed its appreciation for 25 years of good will and cordial business relations between the Society and Mack Printing Company by presenting a certificate to Mr. Mack which he accepted on behalf of his employees.

* * *

C. E. BREGENZER, after 22 years of service with The American Society of Mechanical Engineers as advertising representative on MECHANICAL ENGINEERING and the ASME Mechanical Catalog, has reached retirement age. He will continue on the staff as counselor until transition is effected, it was announced by F. Lask, advertising manager, on Oct. 25, 1949.

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C. R. TUNISON, a graduate of Cornell University, who for four years was an engineering officer in the U. S. Navy and later a sales engineer for manufacturers of industrial products, will take over Mr. Bregenzer's position.

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O. B. J. FRASER, Mem. ASME, assistant manager, Development and Research Division, The International Nickel Company, Inc., New York, N. Y., was elected president of the American Welding Society for the year 1949–1950. Mr. Fraser took office at the AWS annual meeting in October. The other officers elected were: Harry W. Pierce, New York Shipbuilding Corporation, Camden, N. J., first vice-president; Charles H. Jennings, Westinghouse Electric Corporation, Buffalo, N. Y., second vice-president; L. C. Stiles, Chicago Bridge and Iron Company, Birmingham, Ala., third district vice-president; John A. Grodrian, Bendix Corporation, South Bend, Ind., district vice-president; W. F. Boyle, The Pelton Water Wheel Company., San Francisco, Calif., vice-president of the Western district; and A. F. Davis, Mem. ASME, The Lincoln Electric Company, Cleveland, Ohio, as director.

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LESTER T. AVERY, president of the Avery Engineering Company, Cleveland, Ohio, was nominated for president of the American Society of Heating and Ventilating Engineers in 1950. The nomination was announced on Oct. 31, 1949, at the society's headquarters, 51 Madison Avenue, New York, N. Y. Other nominees are: First vice-president, Lauren E. Seeley, Mem. ASME, dean of the college of technology, University of New Hampshire, Durham, N. H.; second vice-president, Ernest Szekely, Mem. ASME, president, Bayley Blower Co., Milwaukee, Wis.; treasurer, R. F. Taylor, consulting engineer, Houston, Texas.

ASME NEWS

Twelfth AIME-ASME Joint Fuels Conference Honors L. A. Shipman

THE Twelfth Joint Fuels Conference of the American Institute of Mining and Metallurgical Engineers and The American Society of Mechanical Engineers was blessed with excellent weather and a perfectly appointed meeting place in the historic French Lick Springs Hotel, French Lick, Ind., Oct. 26-27, 1949. The total registration was over 230.

From the time E. R. Price, chairman of the AIME Coal Division, welcomed the members of the two Societies and praised them for their ability to work and get along together, until the final session was dismissed by C. A. Reed, director of engineering, National Coal Association, the conference moved along in excellent well-planned fashion.

The high light of the annual banquet was the presentation of the Percy Nicholls Award for 1949 to Larry A. Shipman. Mr. Shipman is past-chairman of the AIME Coal Division and has been active in both societies. He was one of the moving forces of the Percy Nicholls Award, inasmuch as Mr. Nicholls was a close personal friend. The speaker at the banquet was Russell I. Richardson, a state representative from Boone County, Ind. Mr. Richardson described a trip to England to view socialism at firsthand, and held the audience spellbound for 50 minutes in describing the loss of liberty, the high taxation, and general curbing of personal initiative of England to socialism.

Thermal Driers

The first paper, "Moisture Control With Flash Driers," was presented by F. P. Calhoun, assistant production manager, Rochester and Pittsburgh Coal Company, Indiana, Pa. Explaining that thermal driers are becoming increasingly important in the marketing of fine coal to lower the moisture to acceptable limits and prevent freezing in wintertime, he gave an excellent description of the flash driers in use by his company. The problem is somewhat complicated by the effort to recover all the extreme fines. Constant control of the temperature is of course of vital importance, and with a proper control of the moisture content entering the drier, the dried product has a reasonably constant moisture content. Adequate storage capacity ahead of the drier will insure a constant flow and prevent the balling of fine coal, both of which are of considerable importance. Overdried coal will cause a considerable dust nuisance. Coal that is too hot when delivered to the railroad cars has a tendency to have a moisture condensation in the cars and thus cause freezing.

Mr. Calhoun gave as the principal advantages of the flash drier the relatively small amount of coal in the system at any time, thus facilitating starting and stopping the coal flow in the preparation plant, and the fact that drying is done without loss of volatility or otherwise changing the coal consist.

Orville R. Lyons, Heyl and Patterson, Pittsburgh, Pa., discussed the Verti-Vane thermal coal drier as developed by R. E. Baugham of the Central Indiana Coal Company. Coal is fed to this drier at the top and it cascades down over vertical vanes, and the heating air is forced through it at regular low velocity so the dust problem is minimized. The drier works best on +28 or 10-mesh coal, and there has been relatively little experience with coals with zero bottom size. The top sizes up to $1^1/_4$ in. have been dried successfully in the apparatus.

Benefits of Drying

The third paper on the symposium was by John L. Erisman of the Link Belt Company, who gave the principal reasons for drying coal as: to (1) prevent freezing of cars in transit; (2) up-grade the Btu content of coal by reducing the moisture; (3) provide uniform moisture content; and (4) facilitate cleaning by drying ahead of air tables.

The convection method of heat transfer is the one used most widely in the drying of coal.

He traced the development of the multilouver-type drier from the rotolouver type, which was originally developed in England. He also recommended the dewatering of coal fed to driers ahead of the driers as much as possible. He described installations where $1^1/_2$ in. slack was being dried, and others where slurry recovered from a storage pile was being dried successfully. He recommended that screen-type driers should be limited to $^3/_{16}$ in. bottom size and that some method such as centrifuges, or the like, be employed for reducing moisture of the small slack before the drier.

In the discussion period that followed these three excellent papers, the problem of changes in physical or chemical consistence of coal due to drying was discussed at some length. It was felt by some of the discussers that there were some physical changes in the coal which might cause it to absorb moisture more readily after drying. Others had not noticed this phenomenon and felt it was not important.

The use of dried coal for coke making was discussed at some length and again there was some diversity of opinion. The preponderance seemed to be that the heat-drying of coal did not impair its value for coking and for general use. The cost of heat drying was also discussed, with a considerable diversity of opinion as to just what the actual cost might be, primarily due to different conditions under which the driers might be used and the amount of water which would be removed by the drier. The highest estimate was 40 cents per ton, and the lowest estimate was 10 cents per ton.

Atomic Fuel Supply

At the Wednesday luncheon, Ward F. Davidson, research engineer, Consolidated Edison Company of New York, Inc., discussed atomic power and fuel supply, and pointed out the problems that must be solved before atomic power can become a reality. He prefaced his remarks with the statement that "any discussion of the possibilities of utilizing atomic or nuclear fuels is scarcely more than daydreaming." He explained the difference in fission and ordinary chemical reaction, by saying that in a chemical reaction the atoms remain unchanged. In fission, the nucleus of the atom separates into two parts, forming a nuclei of two new atoms. He pointed out that the problem of controlling fission was of great importance and also that atomic power plants would have to be well shielded from the operators and also from polluting the air, ground, or water. There is also the problem of disposing of the spent fuel which still is quite radioactive. Even if a set method of heat generating were developed, it would still take some means of transfer to make steam or some other medium for heat transfer through a turbine or similar prime mover. The problem of contamination in this case is considerable. The structure to house the atomic piles and even the metals used in the heat exchangers in turbines and piping, would have to be carefully selected, because many materials are weakened or damaged by radiation. He pointed out that if all the problems could be solved, such as feeding the fuel to the plant, suitable reclaiming, proper shielding, proper heat transfer either in a single-stage or possibly in a two-stage, that is, having a primary and secondary heat-transfer medium, and the plant could be safe to work in, it might cost as much as $370 per kw for the complete nuclear power station.

Steam-Boiler Development

John Van Brunt, Combustion Engineering-Superheater, Inc., New York, N. Y., traced the design of steam generators through at least 20 years. Rapid development stems from the successful use of pulverized coal fired in steam boilers, as water cooling was added to the furnace first in the form of water grates, thence to partial and complete cooling of the furnace surface. This doubled heat-release rates from around 10,000 to 12,000 to 20,000 or 24,000 Btu per cu ft. Water cooling led to larger furnaces with larger capacities so that a boiler with water cooling had nearly double the capacity of the same boiler with the then conventional refractory furnace.

With the advent of the first high-pressure boiler in 1925, came a new era in boiler design. Most of the early high-pressure boilers were topping units and were fired with pulverized coal. The trend toward use of a wider selection of coals came in at this time and it was realized that liberal design would eliminate the slagging and costly shutdowns which happen

with variations in coal quality, or when the low-grade coal substitutes for a higher-grade coal. A period of evolution of design followed, with new data on furnace performance being obtained such as heat absorption, effect of burner location, type of furnace-wall construction, excess air, flame contour, slag, and ash deposits. Superheaters were redesigned for the high temperatures and special dampers were installed to by-pass the gas through single and double-stage superheaters.

Recently the reheat cycle has been revised, primarily because of the increased cost of coal and the urge for economy. Steam temperatures have gone up to 1050 F and 1000 F reheat. Furnaces have been streamlined so there are no dead spots. They have been designed with lower combustion and heat-release rates, wide-spaced superheater elements, straight-through gas passages without baffles, and relatively low gas velocity and draft loss, with increased emphasis on tight settings. Soot blowers have been increased both in numbers and efficiency to maintain clean settings.

Fuel-Burning Equipment

R. K. Allen, staff engineer, The Babcock & Wilcox Company, New York, N. Y., presented the paper, "Fuel-Burning-Equipment Developments for Available Coal, Oil, and Gas Fuels." It is recognized that impurities in coal, particularly ash, and to some extent sulphur, are the most troublesome problems in design. No. 6 oil, which is most commonly used in larger boilers has, compared to coal, a relatively small amount of ash, but may have considerably more sulphur than coal, and thus may cause serious slagging and corrosion problems. Natural gas, where available at comparable cost to oil or coal, is considered an ideal fuel because it is normally clean, there is no handling problem, and it is usually smokeless. Trouble caused from ash and particularly slagging or clinkering, has been allayed to some extent by extensive water cooling, but the type of firing equipment has considerable to do with the problem. Whereas the underfeed stoker is probably the most critical in so far as slagging and clinkering are concerned, the chain grates are the least critical in so far as stack discharge is concerned. Sulphur is an important problem and the flue-gas temperatures must be increased as the sulphur content of the coal increases to prevent corrosion.

A recent innovation, he continued, has been the cyclone furnace, which was primarily developed for the burning of low-grade high-ash coals with a minimum of stack discharge and low excess combustion air. All of the commercial cyclone furnaces to date, since the first development furnace, have been of larger capacity, and further testing must necessarily be done to determine the suitability of cyclone furnaces for smaller installations. Coals ranging from low-volatile high-rank coals to North Dakota lignite have been successfully burned in the horizontal cyclone furnace. However, high-fusion coals will need to wait further developments. A recent installation of a cyclone-furnace-fired boiler has a capacity of 600,000 pounds of steam flow per hour at 1325 psi at 1010 F, using Northern Illinois coal. The principal development in oil firing in the past few years is larger-capacity burners. Today oil burners with a capacity up to 6500 lb per hr are in use.

Froth Flotation

"Some Factors Influencing the Froth Flotation of Coarse-Coal Products," by Shiou-Chuan Sun and R. E. Zimmerman, Pennsylvania State College, State College, Pa., was ably presented. It was pointed out that the maximum size of bituminous and anthracite coal particles which can be efficiently floated in a laboratory Fagergren flotation machine is found to be, respectively, 3 × 6 and 14 × 20 mesh. The factors influencing the froth flotation of coarse mineral particles are aeration, agitation, pulp turbulence, flotation reagents, and mineral density. The phenomena of flotation of coarse particles can be interpreted by means of a proposed multibubble hypothesis. The optimum rate of aeration for the flotation of coarse particles in a laboratory Fagergren flotation machine is in the vicinity of 450 cc air per square inch per minute. The minimum amount of agitation required for the flotation of coarse particles must be large enough to keep the particles in suspension, and is increased with the increase of mineral density and particle size. Violent pulp turbulence, usually resulting from excessive aeration or agitation or both is detrimental to the successful flotation of coarse particles. Other factors being constant, the coarseness of floatable particles to a certain limit can be increased with the improvement of flotation reagents. The upper floatable size limit of mineral particles under the most optimum conditions of flotation is reduced with the increase of mineral density. Deep scraping is needed to remove the floated coarse particles from a flotation cell.

Coal-Tipple Control

"Laboratory Plant Control" was presented by James J. Merle, assistant preparation manager, and Richard A. Mullins, chief chemist, of the Ayrshire Collieries Corporation, Indianapolis, Ind. In a modern coal tipple where it is desired to keep the product constant it requires a laboratory control. Ayrshire Collieries have such a system in operation, staffed with a chemist, assistant chemist, and technician. Samples are taken and analyses run, and a close check kept with the operating personnel so that the product may be kept under careful standards. The paper describes the methods used, laboratory setup, types of report forms used, and the zones of each person. It also gives the results of the type of close control. It shows that the use of a control laboratory at the washing plant and a central laboratory at all the mines has a labor cost of $0.013 per ton, and that the cost of supplies and maintenance was negligible. A laboratory system can be of value only if it is well organized and both the operating and sales companies make full use of the information it supplies. The maintenance of a uniform product which can be furnished to the consumer is a valuable aid in the selling of coal and keeping it sold.

Ignition Baffles

Experimental work on the use of ignition baffles with single-retort stokers was reported on by T. S. Spicer, from Pennsylvania State College. The ignition baffle consists of a refractory baffle located from 18 to 24 inches above the retort of industrial or commercial stokers, suitably supported on water tubes. The baffle extends the length of the firebox and it is approximately half its width with gas passages on each side. The use of the baffle increased both the efficiency and dependability of the single-retort stoker, as well as eliminating the black center which is so often found in this type of burning equipment. It also eliminated the necessity for working the fuel bed by hand, and of course decreased smoke to a very small part of that emitted without its use. It was reported that in a firebox-type boiler rated at 35 hp the cost of the complete baffle, which was installed by the State College maintenance men, was less than $200. Inasmuch as many installations, particularly in internal furnaces, such as the firebox type, have trouble in maintaining ignition, this seems to be a valuable forward step in insuring trouble-free operation. Blowholes, clinkers, and slagging should be materially reduced by the use of this type baffle.

Reported by CARROLL F. HARDY, assistant secretary, ASME Fuels Division.

ASME IIR Division Holds Successful Conference

THE Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers participated in the fourth Instruments Conference and Exposition which was held at the Municipal Auditorium, St. Louis, Mo., Sept. 12–16, 1949. The Conference was sponsored jointly by the Instruments Society of America, the Instruments and Measurements Committee of the American Institute of Electrical Engineers, American Institute of Physics, Scientific Apparatus Makers Association, National Telemetering Forum, and the ASME.

The meetings were attended by 400 engineers and engineering executives engaged in the instrument industry. Among the papers contributed by the ASME were those on adjustment of regulators, international temperature scale of 1948, attenuation of oscillatory pressures in instrument lines, control system for distillation towers, and practical approximations for summarizing square function measurements of two flows.

Technical sessions sponsored by the other participating organizations covered production processes, testing, inspection, and instrumentation analysis of scientific instruments.

There were 150 exhibits of instrument manufacturers displaying products of all branches of the industry.

Westmoreland Subsection Juniors Hold First Meeting

THE FIRST meeting of the newly organized Junior Group of the Westmoreland Subsection of the ASME Pittsburgh Section was held on Tuesday, Oct. 4, 1949, in Greensburg, Pa.

A panel discussion was held with William

L. Kennicott, chief engineer, Kennametal, Inc., Latrobe, Pa., and John C. Redmond, chief research engineer of the same company, as speakers.

Mr. Kennicott spoke on "Sintered Hard Carbides and Their Uses." He traced the development of these compounds which are used to lengthen the life and increase the capabilities of today's production machinery. Wire dies, nylon and homogenizer spray nozzles, cutting tools for removing metal, digging coal, and drilling into rock, and dies for metal forming, he said, were only a few of the applications where man's productivity has been increased or new products made more readily available. In the machine-tool industry unbelievable advancement has been made as evidenced by the example where the production time for a 14-in-long pinion shaft forging (machined all over) was cut from a number of minutes to 27 seconds in spite of former confidence that the time for the job could never be reduced by more than 2 or 3 seconds. New tooling has recently reduced the time to $7\frac{1}{2}$ seconds. This has all happened in the last two or three years in an industry that has used cemented-carbide tools for over 15 years.

Mr. Redmond spoke on "Cemented Carbide Compositions for High Temperatures." Within the last $1\frac{1}{2}$ years his company has introduced a number of compositions that have amazing properties at high temperature. The compositions are essentially titanium carbide and cobalt or nickel. They have had specimens of these compositions, which are about two thirds the density of steel, show tensile strength in excess of 60,000 psi at 1800 F. Their resistance to thermal shock and fatigue also excels the materials now in use in this range. Application to gas-turbine construction is being thoroughly investigated. The material also seem destined for extensive use in molten metals and molten glass, hot extrusion dies, and resistance heating elements.

A speaker's dinner preceded the meeting at which time the junior engineers had the opportunity to meet the speakers and to meet one another.

The group plans to include a number of panel discussions in their program for the year. Junior engineers will make up some of the panels.

The officers of the group are Justin C. Dygert, Elliott Company, Jeannette, Pa., chairman; Vernon Gaskell, Robertshaw Fulton Controls Company, Youngwood, Pa., vice chairman; John Glessner, Elliott Company, secretary; and Martin Kylor, Walworth Company, Greensburg, Pa., treasurer.

About 30 engineers from more than half a dozen concerns attended this first meeting of the Junior Group.

Actions of the ASME Executive Committee

At a Meeting at Headquarters on October 19, 1949

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, Oct. 19, 1949.

There were present James M. Todd, chairman, T. E. Purcell, vice-chairman, F. S. Blackall, Jr., E. J. Kates, of the Executive Committee; J. H. Lawrence (Finance), K. W. Jappe, treasurer, E. G. Bailey, past-president, A. R. Mumford, vice-president, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary. G. B. Pegram and George A. Stetson were also present part time.

Resignation of Treasurer

The resignation of K. W. Jappe, treasurer of the Society since 1944, was noted. A committee consisting of E. G. Bailey, R. M. Gates, and A. R. Mumford was appointed to take up the matter of a new treasurer.

Amendments to Constitution and By-Laws

A suggestion calling attention to the need for clarifying Article B4, Pars. 3 and 8, and B6A, Par. 16 was noted. These paragraphs deal with qualifications for admission, and to the duties of the Board on Honors and Medals Committee. The suggestions were referred to the Constitution and By-Laws Committee.

National Management Council

Following a discussion of the general principles of solicitation of funds by component bodies of the Society for noncomponent organizations, it was voted to approve without prejudice and without establishing a precedent, the 1949 solicitation of contributions from individual members of the Management Division for support of the National Management Council.

Research Agreements

Upon recommendation of the Board on Technology, the following research agreements were approved; (1) Project covering heat conductivities of gases with the Massachusetts Institute of Technology; (2) a project covering the effects of varying silicon-aluminum ratios, resulting from different deoxidation practices, on the creep properties of carbon steels; also on the preparation, circulation, and evaluation of questionnaires on the elevated-temperature properties of carbon and low-alloy steels, and of austenitic stainless steels, with the Battelle Memorial Institute.

New Publication Plan

The report of the Publications Committee on experience with the new publication plan was accepted (see pages 1032–1033 of this issue).

Resolution of Thanks

On behalf of the Society, resolutions were voted expressing thanks and appreciation to the local Executive Committees and other local committees who contributed to the success of the Semi-Annual Meeting in San Francisco and the Fall Meeting in Erie.

Report to ECPD

A statement on activities of the Society in relation to ECPD was approved. The test of this statement forms a part of the report on the 1949 ECPD annual meeting (see pages 1025–1027). It comments, among other matters, on the creation of an ASME consultative group to ECPD composed of six engineering societies working in the field of mechanical engineering.

Honors and Awards

Election of the following to honorary membership was confirmed: Oliver V. S. Bulleid, Dublin, Eire; Samuel W. Dudley, Hamden, Conn.; and Roy C. Muir, Schenectady, N. Y.

The following awards for 1949 were approved: *ASME Medal*, to Fred L. Dornbrook, Milwaukee, Wis.; *Worcester Reed Warner Medal*, to Fred B. Seely, Urbana, Ill.; *Melville Medal Award*, to Harold B. Maynard, Pittsburgh, Pa., for his paper "The Role of Scientific Management in World Recovery"; *Charles T. Main Award* to Stanley M. Kovacheff, Detroit, Mich., for his paper "The Increasing Importance of Science in Engineering"; *Postgraduate Student Award* to Daniel R. Fisher, Aberdeen, Md., for his paper "The Effect of Evaporative Cooling on a Compressible Fluid Flowing in a Duct"; and the *Undergraduate Student Award* to George D. Lewis, Cromwell, Conn., for his paper "Some Natural Limitations on Space Travel."

Hall of Fame

It was noted that A. C. Monteith has been designated by the AIEE to represent that organization in the project sponsored by the ASME nominating George Westinghouse for the Hall of Fame in 1950.

Sections

A petition for the formation of an ASME Section in Mexico City, Mexico, filed by 30 members residing in Mexico, was received and held for action by the Council at the Annual Meeting.

1950 Power Show

Letter-ballot approval of the Executive Committee for ASME participation in the 1950 Power Show was approved.

Certificates of Award

Policy for granting of certificates of award was reviewed. It was voted that the retroactive provision granting certificates of award for outstanding Society service be rescinded.

Upon initiation of their associates and approval by ASME officers, certificates of award were granted to the following, retiring chairmen of Sections, Committees, and Divisions: Roger A. Martin, Atlanta; Ramsey M. Reed, Birmingham; L. F. Pohl, Chattanooga; Arthur S. Wells, East Tennessee; E. M. Williams, Greenville; Mark L. Ireland, Jr., Virginia; Charles M. Allen, Board on Honors (retiring member); E. R. Granniss, Safety Committee; David S. Frank, Fuels; William Raisch, Petroleum; E. D. May, Wood Industries.

Use of Society Emblem

Permission was granted to the North Carolina State College of Agriculture and Engineering to reproduce the ASME emblem without initials in the floor of the main

entrance of its new Mechanical Engineering Building.

Joint Awards

Awards of the 1949 Hoover Medal to Frank B. Jewett, past-president of the AIEE, and the 1949 Gantt Medal to Arthur C. Spurr, president, Monongahela Power Company, were noted.

London Conference

The Secretary's report on the Conference of Representatives from Engineering Societies of Western Europe and United States held in London, Sept. 19–23, 1949, was noted. The report was referred to the Council and the Board of Public Affairs for consideration.

With reference to an invitation received from the Society of Instrument Technology (British) by the ASME Industrial Instruments and Regulators Division to establish liaison representatives between the two groups, the Committee approved, without expense to ASME, the proposed co-operation.

Dr. W. F. Durand's Awards

A gift of eight medals and awards from Dr. W. F. Durand to be effective upon the death of his son was accepted. The medals are those conferred upon Dr. Durand by leading engineering organizations.

Appointments

Appointments to committees and joint activities recommended by the Organization Committee were approved.

The following presidential appointments were approved: Tellers of Election, 1950, George E. Hagemann, R. H. McLain, P. T. Onderdonk; EJC Group on Increased Unity in Engineering Profession, E. J. Kates; ASCE Committee to Survey Student Activities at Engineering Colleges, E. W. O'Brien, alternate, P. B. Eaton; NACA Lewis Flight Propulsion Laboratory, annual inspection, Cleveland, L. C. Peskin; International Heat and Power Exhibition and Third International Measuring Exhibition and Conference, Stockholm, Alex N. Engbloom; United Nations Scientific Conference on Conservation and Utilization of Resources, Lake Success, E. G. Bailey, R. M. Gates; Stanford University, inauguration of president, W. F. Durand; Colorado School of Mines, 75th anniversary, Frank H. Prouty; Duke University, inauguration of president, E. E. Williams; Ohio Northern University, Ada, Ohio, inauguration of president, Samuel R. Beitler; Washington State College, Pullman, Wash., dedication of Mechanics Arts Building, W. A. Pearl.

Petroleum Mechanical-Engineering Problems Discussed at ASME Conference

TWO hundred mechanical engineers attended the interesting meeting of the Petroleum Division at the Oklahoma Biltmore Hotel, Oklahoma City, Okla., Oct. 2–5, 1949. Twenty-seven papers were presented on timely subjects in the petroleum industry. Production problems discussed were pumping-well studies, well-control manifolds, secondary recovery-equipment selection, mud pumps, Diesel-electric drilling rigs, and stage separation. Transportation subjects talked about were: partial loop control, economics of pumping-unit selection, turbocharging of pumping engines, flowmeter research, pressure loss in pipe and fittings, flow characteristics in large lines, surge problems, and recent trends in river transportation of petroleum. Refining papers treated gas turbines in the refinery, development and usage of pipe flanges, welds at subzero temperatures, control-valve application, corrosion-resistant linings for refinery vessels, pumps and compressors; and instrumentation. Well attended were the sessions presenting a series of papers on the problems encountered in the design of coal-hydrogenation plants.

Early registrants on Sunday evening were treated to an illustrated travel talk by Dean W. H. Carson, University of Oklahoma, on his recent trip to the Middle East. Introduced by W. H. Stueve, chairman of the Local Arrangements Committee, the Honorable Roy J. Turner, Governor of Oklahoma, welcomed the Society at the Monday noon luncheon and presented to President Todd an honorary-colonel certificate. Burt E. Hull, president of Trans-Arabian Pipe Line Company, followed with the opening technical talk of the meeting on the problems of building pipe lines in the Middle East. Monday evening the first commercial installation of a gas turbine was viewed, after which a fellowship party was enjoyed.

Speaker at the luncheon on the second day was J. A. Markovits, U. S. Bureau of Mines, on the subject of coal hydrogenation. He was introduced by R. J. S. Pigott, Fellow ASME, director of engineering, Gulf Research & Development Company, Pittsburgh, Pa.

JAMES M. TODD, PRESIDENT ASME, AND W. H. STUEVE, OKLAHOMA GAS AND ELECTRIC COMPANY, LOOKING AT SWITCHBOARD OF A GAS TURBINE ON INSPECTION TRIP DURING THE ASME PETROLEUM MECHANICAL-ENGINEERING CONFERENCE HELD IN OKLAHOMA CITY, OKLA.

At the dinner on Tuesday evening, Dean W. H. Carson, College of Engineering, University of Oklahoma, served as toastmaster. He introduced President Todd who presented a certificate of appreciation to retiring Petroleum Division chairman, William Raisch, consulting engineer, New York, N. Y., for his past five years' work in reorganizing the ASME Petroleum Division. Fellow-grade certificates were presented to Dean W. H. Carson, W. H. Stueve, D. O. Barrett, and Gwynne Raymond.

The ladies' program, which included a luncheon and style show in the Empire Room of the Black Hotel, was sponsored by the Ladies Entertainment Committee of which Mrs. W. H. Stueve was chairman.

Prominent in the handling of local arrangements was J. H. Field, Sohio Petroleum Company, who was much in evidence at the headquarters desk serving the needs of attending engineers.

(Reported by E. W. JACOBSON, secretary, ASME Petroleum Division.)

ASME Sections

Coming Meetings

Arizona: December 10. Section meeting at Phoenix. Subject: Transportation. Speaker to be announced.

Chicago: December 20. Industrial Instruments and Regulators Division at Western Society of Engineers rooms. Subject: Automatic Control (including demonstration) by R. Pond.

Cincinnati: December 1. Engineering Societies Building at 8 p.m. Subject: Mechanical Engineering in Atomic-Energy Research, by R. G. Olt.

Detroit: December 13. Rackham Memorial Building. Combined meeting with Junior Group.

Erie: December 1. Luncheon meeting at the Moose Club at 12:15 p.m. Subject: Roads and Highways. Speaker: R. F. Smock.

Kansas City: December 12. University Club at 8 p.m. Speaker: N. T. Veatch.

Southern California: December 10. Steam Power Division. Field trip. Redondo Steam Station, 11th and Hermosa Avenue, Redondo Beach. Joint inspection trip through the Southern California Edison Company Steam Station by the ASME-AIEE. Speaker: T. M. Hotchkiss.

Section Activities

REPORTS of the following ASME Section Meetings were received recently at headquarters.

Atlanta, Oct. 14. Speaker: G. Farrar. Subject: Power by Which We Live. Attendance: 40.

Boston, Sept. 29. Speaker: R. D. Stauffer. Subject: The New Kendall Square Steam-Electric General Station, Cambridge Electric Light Company. Attendance: 142.

Cincinnati, Oct. 6. Ladies' Night. Speaker: Prof. P. Heret. Subject: The Moon's Eclipse. Attendance: 143.

Erie, Oct. 25. Speaker: Dr. S. J. Zand. Subject: 300 Years of Vibration Engineering. Attendance: 80.

Iowa-Illinois, Oct. 26. Speaker: O. Blodgett. Subject: Cutting the Cost of Welded Construction. Attendance: 23.

Kansas City, Oct. 5. Speaker: J. M. Todd, president ASME. Subject: Hoover Commission Report. Attendance: 48.

Ontario, Oct. 12. Speaker: T. W. Harris. Subject: Materials Handling in Industry. Attendance: 51.

Philadelphia, Oct. 25. Speaker: H. Weisberg and M. D. Hooven. Subject: Sewaren Generating Station. Attendance: 400.

Rochester, Oct. 13. Speaker: A. H. Candee. Subject: Modern Gearing and How Gear Teeth Are Designed. Attendance: 108.

Rocky Mountain, Oct. 17. Speakers: F. F. Bach and S. J. Kester. Subject: Certain Aspects of the new Colorado Fuel and Iron Corp. Rod Mill. Attendance: 43.

South Texas (Junior Group), Oct. 13. Program: Two films dealing with the actual operations involved in placing under control of two oil and gas wells. Speaker: M. I. Works. Attendance: 35.

Syracuse, Oct. 10. Speaker: E. H. Lang. Subject: Engineering College Preparation in High School. Attendance: 40.

Worcester, Oct. 6. Speaker: J. Stoddard. Subject: Production Possibilities With Tailor-Made Automatic Machines. Attendance: 45.

Student Branch Activities

REPORTS of the following ASME student branch meetings were received recently at Headquarters:

Alabama Polytechnic Institute, Oct. 10. Meeting to recruit members. Film: Precision Casting. Attendance: 101.

Oct. 24. Film: Diesel Engines, presented by the Navy. Attendance: 85.

Brown University, Oct. 13. General discussion led by chairman Philip Kenny. Attendance: 54.

University of California, Oct. 18. Speaker: T. A. Boyd. Subject: Automotive Development. Attendance: 155.

Carnegie Institute of Technology, Oct. 13. Films: The Banshee Turbojet Plane and Inside Story of Link-Grate Stokers. Attendance: 47.

Case Institute of Technology, Oct. 25. Speaker: Prof. Alexander Devigs. Subject: Russian-Dominated Europe. Attendance: 53.

University of Cincinnati, Oct. 5. Organizational meeting. Speaker: F. F. Borries, chairman, Cincinnati Section. Attendance: 151.

Clarkson College of Technology, Oct. 12. Speaker: Dr. T. S. Renzema. Subject: The Physicist in the Mechanical Field (Eng.). Attendance: 152.

Clemson A and M College, Oct. 11. Film: Steam Progress. Attendance: 52.

Oct. 25. Speaker: E. A. Birge. Subject: Contamination Control in Products Pipe Lines. Attendance: 49.

Colorado A and M College, Oct. 5. Business meeting and showing of film: The Last Mile. Attendance: 58.

Oct. 19. Speaker: Mr. Lockwood. Subject: Presentation of student-branch charter. Attendance: 93.

Columbia University (Mech. Div.), Oct. 7. Organization meeting. Speaker: C. Anderson. Attendance: 55.

Oct. 13. Speaker: R. H. Stowers. Subject: Problems Confronting Aircraft Industry. Attendance: 40.

University of Connecticut, Oct. 6. Speakers: Messrs. Coogan and Stephens. Subject: Elections—The Future of Our Group. Attendance: 100.

Oct. 27. General business meeting to plan for future field trips. Attendance: 70.

Cooper Union (Day), Oct. 10. Films: Harnessing Liquids and Crude-Oil Distillation. Attendance: 12.

Oct. 24. Film: Rhapsody in Speed. Attendance: 31.

Cornell University, Oct. 6. Speaker: Prof. P. B. Eaton, vice-president ASME. Subject: An Engineer Looks at China. Attendance: 85.

Oct. 18. Speaker: H. J. Loberg. Subject: Sales Engineering. Attendance: 77.

University of Delaware, Oct. 4. Film: United States Steel. Attendance: 60.

Drexel Institute of Technology, Oct. 5. First meeting of school year. Films: Shooting Star and Thunderbolt. Attendance: 60.

Duke University, Oct. 11. Organization meeting. Film: Quality in the Making. Attendance: 42.

Fenn College, Sept. 30. Opening business meeting. Attendance: 105.

Oct. 28. Speaker: J. W. Love. Subject: Industry—The Day After Tomorrow. Attendance: 75.

University of Florida, Oct. 4. Opening rally. Attendance: 64.

Oct. 17. Film: The Scavenging and Supercharging of Diesel Engines. Attendance: 65.

George Washington University, Oct. 5. Joint meeting with branches of other national engineering societies on the campus. Speakers: Faculty members and officers of the student engineering societies. Attendance: 250.

University of Idaho, Oct. 3. Films: Stainless Steel and Jet Propulsion. Attendance: 43.

Illinois Institute of Technology, Oct. 6. Speaker: F. Nagler, Life Member ASME. Subject: Why Join the ASME? Attendance: 250.

Oct. 18. Speaker: R. Smirl. Subject: Automatic Transmissions. Attendance: 275.

University of Illinois (Navy Pier Division), Sept. 27. Organization meeting and elections. Attendance: 41.

Oct. 25. Speaker: W. W. McIlvain. Subject: Foundry Design and Operation. Attendance: 67.

State University of Iowa, Sept. 28. Election of officers. Attendance: 109.

Oct. 5. Speaker: E. Mielnik. Subject: General Business. Attendance: 82.

Oct. 12. Speaker: Prof. G. Robeson. Subject: British System of Democracy. Attendance: 93.

Oct. 19. Speaker: Prof. E. C. Lundquist. Subject: The ASME. Attendance: 96.

Oct. 26. Speaker: Prof. J. Cobitz. Subject: Relation of Philosophy and the Exact Sciences. Attendance: 109.

Kansas University, Oct. 6. Smoker and presentation of charter. Speaker: J. M. Todd, president ASME. Attendance: 78.

ASME Calendar

of Coming Events

March 30–April 1, 1950
ASME, Region VIII, Annual Meeting, Baker Hotel, Dallas, Texas

April 12–14
ASME Spring Meeting, Hotel Statler, Washington, D. C.
(Final date for submitting papers was Dec. 1, 1949)

April 24–26
ASME Process Industries Division Conference, William Penn Hotel, Pittsburgh, Pa.
(Final date for submitting papers was Dec. 1, 1949)

June 12–16
ASME Oil and Gas Power Division Conference, Lord Baltimore Hotel, Baltimore, Md.
(Final date for submitting papers—Feb. 1, 1950)

June 19–23
ASME Semi-Annual Meeting, Hotel Statler, St. Louis, Mo.
(Final date for submitting papers—Feb. 1, 1950)

June 22–24
ASME Applied Mechanics Division Conference, Purdue University, Lafayette, Ind.
(Final date for submitting papers—Feb. 1, 1950)

Sept. 11–15
ASME Instruments and Regulators Division Conference, Municipal Auditorium, Buffalo, N. Y.
(Final date for submitting papers—May 1, 1950)

Sept. 19–21
ASME Fall Meeting, Hotel Sheraton, Worcester, Mass.
(Final date for submitting papers—May 1, 1950)

Sept. 25–27
Petroleum Mechanical Engineering Conference, Hotel Roosevelt, New Orleans, La.
(Final date for submitting papers—May 1, 1950)

(For Meetings of Other Societies see page 1069)

Kansas State College, Oct. 6. Speaker: J. M. Todd, president ASME. Subject: Responsibilities of Engineers. Attendance: 235.

Oct. 27. Speaker: H. E. Degler. Subject: Water-Cooling Towers as Related to Water Conservation. Attendance: 164.

University of Kentucky, Oct. 6. Election of council members. Attendance: 214.

Oct. 13. Speaker: Prof. A. J. Meyer. Subject: Aircraft Engines. Attendance: 240.

Oct. 20. Two technicolor films of scenic views from Kentucky and Canada. Attendance: 263.

Oct. 27. Film: U. S. Steel. Attendance: 322.

Lafayette College, Oct. 6. Speaker: Mr. McConaghy. Subject: Design Applications and Utilization of Pumps. Attendance: 54.

Oct. 27. Speaker: F. R. Benedict. Subject: Influence of Materials on Future Design. Attendance: 38.

Lehigh University, Oct. 6. Speaker: C. D. Miller. Subject: The Nature of Knock in Engines as Shown by Ultra-High-Speed Motion Pictures. Attendance: 120.

Louisiana Polytechnic Institute, Oct. 25. Business meeting. Attendance: 34.

Louisiana State University, Sept. 27. Opening meeting. Speaker: W. N. Canulette. Attendance: 68.

University of Louisville, Oct. 20. Film on internal-combustion engines. Attendance: 114.

University of Maryland, Oct. 17. Speaker: F. H. Copeland. Subject: Aircraft Weight Engineering. Attendance: 75.

Massachusetts Institute of Technology, Oct. 24. Membership drive. Speaker: Prof. R. A. Soderberg. Subject: Are Course II Men Prepared for Industrial Responsibility? Attendance: 250.

University of Michigan, Oct. 10. Speaker: J. M. Todd, president ASME. Subject: Advantages of ASME Membership. Attendance: 175.

Oct. 19. Films: Steam for Power; Design for Welding. Attendance: 126.

Michigan College of Mining and Technology, Oct. 4. Rally for new and old students, and smoker. Speaker: Prof. A. P. Young. Attendance: 130.

Oct. 11. Speaker: H. Horldt. Subject: Engineering in General. Attendance: 50.

Oct. 25. Speaker: Prof. C. R. Moss. Subject: Job Hunting. Attendance: 100.

Michigan State College, Oct. 12. Business meeting. Attendance: 67.

Oct. 26. Speaker: J. Campbell. Subject: Michigan State College Power Plant. Attendance: 57.

University of Minnesota, Oct. 5. Speaker: L. Borst. Subject: Various Activities of the Senior ASME and the Responsibilities of Junior Members. Attendance: 143.

Oct. 12. Speaker: Mr. Knoll. Subject: Talk on the organizational structure of Procter and Gamble Mfg. Co. Attendance: 31.

Oct. 26. Program: Film on reforestation with discussion by Mr. Tegge. Attendance: 46.

Mississippi State College, Sept. 29. Membership drive and welcome to new members. Attendance: 60.

Oct. 13. Speaker: A. G. Holmes, Jr. Subject: Multistage Rotary Pumps. Attendance: 62.

University of Missouri, Sept. 28. Speakers: Faculty members. Subject: Advantages of ASME. Attendance: 114.

Oct. 12. Business meeting. Speaker: Dean Croft. Subject: Get Acquainted. Showing of film on aluminum. Attendance: 42.

Montana State College, Oct. 5. Election of officers. Attendance: 70.

University of Nebraska, Sept. 28. Speaker: R. Lindskog. Subject: The Atom. Attendance: 200.

University of New Hampshire, Oct. 3. Organization and general business meeting. Speaker: Dean Seeley. Subject: Value of Participation in ASME. Attendance: 75.

Oct. 17. Business meeting and film on Diesel power. Attendance: 96.

Oct. 24. Speaker: Prof. E. H. Stolworthy. Subject: Types of Job Opportunities. Attendance: 76.

New Mexico College of A and M Arts, Oct. 21. Speaker: R. Steinman. Subject: Essential Equipment of a Power Plant. Attendance: 55.

College of the City of New York, Oct. 20. Speaker: A. R. Mumford, vice-president ASME Region II. Subject: Narration on a film explaining the workings of the National Organization. Attendance: 150.

Oct. 27. Speaker: J. D. Benson. Subject: Talk, accompanied by film: Electrical Hazards in the Home. Attendance: 125.

New York University (Day), Oct. 6. Program: Film: Steel, Man's Servant, a U. S. Steel movie. Attendance: 150.

Oct. 13. Speaker: R. L. Reich. Subject: Engineering as a Profession. Attendance: 100.

University of North Dakota, Sept. 27. Speaker: Prof. A. C. Burr. Subject: Importance and Advantages of Professional Engineering Societies. Attendance: 46.

Oct. 25. Business meeting. Attendance: 27.

North Dakota Agricultural College, Sept. 29. Introductory meeting. Speakers: W. R. Olsen and A. W. Anderson. Attendance: 40.

Oct. 25. Speaker: Mr. Bigelow. Subject: What an Engineering Graduate Should Expect of a Boss. Attendance: 43.

University of Notre Dame, Oct. 10. Business meeting and promotion of competitors for Charles T. Main contest. Speaker: M. Snider. Attendance: 100.

Ohio State University, Oct. 6. Business meeting. Attendance: 95.

Oklahoma A and M College, Oct. 10. Program: Film of the U. S. Bureau of Mines on Industries of Oklahoma. Attendance: 75.

Pennsylvania State College, Oct. 11. Speaker: Dean Hammond. Subject: Registration of Members for 1949-1950. Attendance: 201.

University of Pittsburgh (Mech. Div.), Sept. 29. Speaker: Prof. T. G. Beckwith. Subject: Membership in ASME. Attendance: 163.

Oct. 6. Speaker: Dr. J. S. Taylor. Subject: Entertaining Mathematics and Magic. Attendance: 163.

Oct. 20. Speaker: Dr. J. M. Ferguson. Subject: Questions and Answers on Today's Problems. Attendance: 163.

Polytechnic Institute of Brooklyn (Day), Oct. 4. Speaker: A. R. Mumford, Fellow ASME. Subject: The ASME and You. Attendance: 130.

Oct. 4. *Evening Branch*. Membership rally. Welcoming address by Prof. W. H. Ruten. Attendance: 139.

Oct. 18 (*Day*). Speaker: G. S. Berge. Subject: Opportunities for Engineers in Industry. Attendance: 63.

Oct. 25 (*Evening*). Business meeting. Film: An Exact Duplicate, product of Gorton Machine Company. Attendance: 65.

Pratt Institute, Sept. 30. Organization and special election meeting. Attendance: 84.

Oct. 28. General business meeting. Attendance: 62.

Princeton University, Nov. 2. Speaker: F. Pennell. Subject: Fatigue Failure in Turbine Shafts. Attendance: 30.

Purdue University, Oct. 11. Speaker: F. Jehle. Subject: ASME Organization. Attendance: 400.

Queens University, Oct. 14. Films: Shipshaw Power Development, and This Is Aluminum. Attendance: 35.

Oct. 21. Film by Babcock & Wilcox, Steam for Power. Attendance: 43.

Rhode Island State College, Oct. 6. Speaker: B. P. Graves. Subject: Advantages of ASME. Attendance: 40.

The Rice Institute, Oct. 3. Business meeting. Attendance: 27.

Oct. 18. Speaker: J. T. Allen. Subject: Cutting Speeds and Design of Machine Tools. Attendance: 33.

Rutgers University, Oct. 6. Organizational meeting. Speakers: K. J. Moser and A. R. Mumford, Members ASME. Attendance: 100.

University of South Carolina, Oct. 4. Speaker: J. R. DeHamer. Subject: Orientation of New Members. Attendance: 52.

Oct. 11. Business meeting. Attendance: 35.

Nov. 1. Business meeting. Attendance: 52.

South Dakota State College, Oct. 5. General business meeting. Attendance: 45.

Oct. 19. General business meeting. Attendance: 40.

University of Southern California, Oct. 5. Membership drive and showing of film. Attendance: 77.

Oct. 21. Speaker: L. Monson. Subject: Role of Mechanical Engineers in the Oil Fields. Attendance: 60.

Stanford University, Oct. 5. Speaker: Prof. L. S. Jacobsen. Subject: Tacoma Narrows Bridge, Failure and Reconstruction. Attendance: 58.

Swarthmore College. Oct. 11. Business meeting. Attendance: 19.

Oct. 18. Business meeting. Election of officers. Attendance: 18.

University of Tennessee, Oct. 5. Speaker: A. Bettinger. Subject: The Advantages of Membership in ASME. Attendance: 64.

Oct. 19. Speaker: Prof. E. S. Fabian of the University. Subject: Problems Facing the Engineer. Attendance: 46.

Texas A and M College, Sept. 27. Election of officers. Speaker: C. W. Crawford. Subject: Advantages of Society Membership. Attendance: 95.

University of Texas, Oct. 3. Speakers: Prof. C. S. Eckhardt, Dr. B. Short, and Prof. V. L. Doughtie. Subject: ASME, History, Purpose, Achievement, and Benefits. Attendance: 268.

Tufts College, Oct. 4. Speaker: F. M. Gunby, vice-president, ASME Region I. Attendance: 50.

Tulane University, Oct. 13. Speakers: Dean Roberts and Prof. A. M. Hill. Subject: Guide Speech for Freshmen. Attendance: 78.

Oct. 20. Speakers: G. S. Schonekas and T. Turker. Subject: Field Trip and By-Laws. Attendance: 26.

Oct. 27. Speakers: Students Viosca, Franklin, and Schonekas. Subjects: Vote on By-Laws and Field Trip. Attendance: 44.

Vanderbilt University, Oct. 5. Membership meeting. Speaker: J. Green. Attendance: 61.

University of Vermont, Sept. 28. Speaker: D. B. Hopkinson. Subject: Services and Benefits of ASME. Attendance: 45.

Oct. 21. Speakers: J. Greene and T. Stafford. Subject: Film by Vermont Marble Company with comment by speakers. Attendance: 64.

University of Virginia, Sept. 28. Program: Short papers by students G. Bland, W. Green, and S. Ochoa. Attendance: 65.

Oct. 20. Speaker: D. A. Holden. Subject: What Industry Expects of the Engineering Graduate. Attendance: 64.

Virginia Polytechnic Institute, Oct. 4. Speaker: Prof. J. B. Jones. Subject: Plans for the New Mechanical-Engineering Laboratory. Attendance: 145.

Oct. 18. Film: Summer Storm, produced by the Westinghouse Corporation. Attendance: 133.

Washington State College, Oct. 6. Business meeting followed by a General Electric sound film on Jet Propulsion. Attendance: 56.

Oct. 20. Film: Petroleum. Attendance: 35.

University of Washington, Oct. 5. Subcommittee organization meeting. Attendance: 37.

Oct. 19. Speaker: Prof. Engel. Subject: Welcome of New Members. Attendance: 104.

Washington University, Sept. 30. Organization of the branch. Attendance: 31.

Oct. 20. Speakers: D. Fischer and C. S. Kippenhan. Subject: Objective and Benefits of Student Membership in ASME. Attendance: 51.

Wayne University, Oct. 5. Speaker: L. Meyer. Subject: ASME's Relationship to Students. Attendance: 70.

West Virginia University, Sept. 29. Organization meeting. Speaker: Prof. H. M. Cather. Attendance: 87.

University of Wisconsin, Oct. 4. Speaker: Prof. B. G. Elliott. Subject: What the ASME Can Mean to You. Attendance: 108.

Worcester Polytechnic Institute, Oct. 20. Opening Rally. Speaker: Prof. Webster. Attendance: 70.

Yale University, Oct. 12. Speaker: N. H. Clitton. Subject: Shapemaster and Air-Gage Tracer. Attendance: 40.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

RECENT GRADUATE, BSE, ME, 25, single, veteran. Willing to travel, will locate anywhere. Also interested in business administration. Will consider any job. Me-557.

INDUSTRIAL ENGINEER, 26, BS, Cornell. Four years' experience including test engineering, supervision, one year time study and methods. Desires industrial engineering, safety, or industrial relations in New York State. Me-558.

MECHANICAL ENGINEER, 40, married, BSME, high honors, operating experience in Diesel-electric, steam-turboelectric, engineering instructor, USNR, design-office experience, steam turbines. Available immediately. Will locate anywhere. Me-559-498-D-3.

EXECUTIVE ENGINEER, 39, Dr.Eng.Sc., chemical and mechanical. Eighteen years, diversified experience. Supervision of plant and process development, design, construction, and operations. Equipment design and applications. Project management and consulting. Me-560.

MECHANICAL ENGINEER, 32, married, professional license. Ten years' experience as project, production, design, and development engineer. Experience on small mechanisms, large special equipment, air-conditioning, and refrigeration equipment. Me-561.

RECENT GRADUATE, 23, married, BSME, desires position in internal-combustion field; however, will consider any good offer. Some drafting experience. Me-562.

MECHANICAL ENGINEER, MS, fifteen years' experience. Design and development heavy machinery with small mechanisms. Diversified projects in mechanical engineering. Excellent background and professional aptitude-test scores. Reference letters on successfully completed projects and patented designs show the achievements. Ability to handle engineering problems and people. Foreign languages. Desires permanent position. Me-563-45-M.

GRADUATE MECHANICAL ENGINEER, 23, BME, Pi Tau Sigma, veteran. One year drafting, one year apprentice-machinist experience. Desires position with future. U.S.A. or Overseas. Me-564.

INSTRUMENT ENGINEER, ten years chemical and metals plants, controls, meters, scales. Know layout, design, procurement, construction, maintenance. Can take charge or work under supervision. Previous ten years piping layout, boiler, and machinery design, testing and service. Mechanical graduate. Me-565.

GRADUATE INDUSTRIAL ENGINEER, 25, married. University of Michigan. Experienced quality control, machine layout, methods study, cost control, materials-handling problems, packaging machinery. Prefer New York or New Jersey. Me-566.

TECHNICAL SALES AND SERVICE, BSME, BA, Languages. 27, married. Experience control equipment, chemicals, personnel. Will locate anywhere if housing is available. Me-567.

RECENT GRADUATE, 22, single, BSIE, Pennsylvania State College. Desires tool or production-engineering work. Prefers machine-tool or oil industries. Will locate or travel anywhere. Me-568.

RECENT GRADUATE, BChE, Polytechnic Institute of Brooklyn, plastic and resin-technology major, high grades. Single, 21, no dependents. Desires production or development position. Location immaterial. Me-569.

MECHANICAL ENGINEER, 31, single, BSME, registered. Eight years' experience in tooling, machine, and product design. Experience includes aircraft, farm tractors, household equipment, utensils, and toys. Has initiative and creative ability. Desires responsible position in small company. Midwest or West. Me-570.

MECHANICAL ENGINEER, 24, single, recent graduate of the University of Pennsylvania, BSME. Desires position with a future in any phase of engineering. Will travel or locate anywhere. Me-571.

MECHANICAL-INDUSTRIAL GRADUATE, presently employed, three years' experience in pip-

[1] All men listed hold some form of ASME membership.

ing design and layout of oil refineries and heating and ventilating, desires position offering better possibilities. Prefers New York, Massachusetts, or East. Me-572.

MECHANICAL ENGINEER, 22, veteran, master's degree from M.I.T., June, 1949, top grades, excellent references. Desires position in heat-power field. Willing to relocate, preferably East. Me-573.

JUNIOR MECHANICAL ENGINEER, 24, single, BE, 1946, Yale. MBA, 1949, Columbia. Management and Economics. One year's experience metalworking and time study. Me-574.

MECHANICAL ENGINEER, 30, single, three and a half years' experience in design, development, research. Desires position in technical sales. Prefers air-conditioning or combustion fields, but will consider others. Will travel. Me-575.

PROJECT ENGINEER, BSME, 1937, experienced in heavy machinery, industrial engineering; presently employed petroleum-industry stress analysis, equipment redesign, and inspection. Desires work directing equipment redesign and testing. Midwest or Southwest preferable, but not essential. Me-576.

POSITIONS AVAILABLE

ENGINEERS. (*a*) Chief mechanical engineer who is thoroughly experienced with computing mechanisms, such as marine instruments, simulators, analog computers, or trainers. Will be required to schedule work and handle production. $6000. (*b*) Design engineer, to act as group leader, who is familiar with above listed mechanisms. $4500. New York, N. Y. Y-2902.

METHODS-ENGINEERING SUPERVISOR, 35–45, graduate, with industrial or mechanical degree, with at least ten years' experience in methods engineering, and experience in working with labor and unions. Will act as assistant to industrial engineer, planning projects to be undertaken and how the methods study is to be made; preparing the way for the changes with all concerned including the Union. Will supervise putting the changes into effect and follow up completion of jobs to see that proper methods are used. Salary open. New Hampshire. Y-2905.

SALES ENGINEER, 30–40, mechanical graduate, with at least five years' sales and service experience in industrial lubricating field, to sell oils and greases. $4000–$5000. Upstate New York. Y-2907.

EQUIPMENT-TEST ENGINEER, 30–45, mechanical graduate, with experience on restaurant equipment, to run efficiency tests, compile data, make analyses, prepare reports covering gas and electric-heated ovens, fryers, ranges, etc. $6000. Southern Virginia. Y-2909.

SHOP SUPERINTENDENT with minimum of five years' experience on small precision machine shop and tooling. Plant employs eight hundred people. $10,000. Connecticut. Y-2937.

CHIEF DRAFTSMAN, 35–45, Must have an engineering degree, and must have had extensive experience in the pulp and paper industry. Will be responsible for the general and detailed supervision of the drafting room, including fifteen mechanical, structural, and electrical draftsmen, and will be responsible for complete and accurate drawings, completion of same on schedule, including design, layout, and estimating. Salary open. New Hampshire. Y-2938–R-6017.

PERSONNEL EXECUTIVE, 35–40, engineering graduate, preferably mechanical, with eight to ten years' industrial-manufacturing and administrative experience, and personnel experience, including recruiting and placement of production-engineering executives and technicians, to analyze and prepare job specifications, contact personnel sources, make selections, etc. Up to $8000. New York, N. Y. Y-2940.

PRODUCTION CONSULTANT, 35–40, graduate engineer, with minimum of five years' experience as production manager for a manufacturing industry. Will be executive in reporting what a number of diversified industries are doing in the line of production. $10,000–$12,000. New York, N. Y. Y-2959.

DESIGNER, mechanical, who has had considerable experience in the design and development of high-pressure valves. $6000–$7500. New York, N. Y. Y-2961.

ENGINEERING MANAGER, 33–42, with an engineering degree, for manufacturer of mass-production metal products. Must have organizational and administrative ability, to manage successfully mass-production stages in the development of several large metal products. $10,000–$15,000. Illinois. Y-2965–R-5990.

ESTIMATOR with at least five to ten years' experience in taking off quantities in industrial and commercial buildings. Must be accurate. $5000–$6000. Northern New Jersey. Y-2976.

RESEARCH ASSISTANT, part-time, for work dealing with the experimental and theoretical study of behavior of metals subjected to combined stresses in the plastic range. The research work could be used for a master's or doctor's thesis in engineering mechanics. $1344. Pennsylvania. Y-2984.

PROJECT ENGINEER, mechanical or electrical graduate, 30–50, with experience of five years or more with small and medium-sized product design and development, primarily mechanical. Able to examine (disassemble and assemble), do necessary drafting, and also work with machinists and modelmakers. Must be able to operate and do work on shop machines in an engineering department of twenty-five for a manufacturing company. Salary open. Illinois. R-5977.

ENGINEERS. (*a*) Process engineer, 30–40, minimum of five years' experience in desiccant and general refrigeration, preferably deep-freeze and frozen-food storage-cabinet application. Some knowledge of tooling and quantity-production methods in this field. (*b*) Assembly foreman, 30–40, experienced in general refrigeration and assembly techniques of refrigeration units for ice cream and frozen-food storage cabinets. Must be able to handle men and maintain good labor relations. Some sheet-metal experience helpful. Salaries open. Michigan. R-5993.

EXECUTIVE ASSISTANT, 30–40, mechanical or electrical graduate, who has had a minimum of five years' operating experience with electric public utility. Personnel experience very desirable, as successful applicant will also head this department. $7000–$9000. Southwest. Y-2988.

ENGINEERS. (*a*) Industrial engineer, 35–45, graduate, with at least five years' methods-analysis experience in general manufacturing including operations of paper converting for staff position with paper-products manufacturer. (*b*) Plant engineer, 35–45, mechanical graduate, with paper-machinery design and operating experience, to supervise maintenance and repair of equipment including special modifications to standard machines. $7500. Massachusetts. Y-2990.

PLANT ENGINEER, 30–40, preferably graduate, with five to ten years' experience with plant maintenance, to supervise department of thirty people; also do simple designs of machinery and conveyers. Able to get along well with people; for manufacturer of building products in Chicago. $5500. R-6002.

DESIGN-DEVELOPMENT ENGINEER, about 40, mechanical or electrical graduate, with experience in industrial and recording instruments. Able to take responsible charge of project department, eventually take over position of chief engineer for a manufacturer. $6000. Illinois. R-6005.

PROJECT ENGINEER, mechanical, 35–50, with ten to twenty years in development design of a line of mechanical office-machinery products. Knowledge of production and assembly problems, commercial-minded; informed about standardization and interchangeability of assembled units, parts, equipment, and able to develop and design independently to meet pre-established specifications. Will prepare original design, make sketches, calculations, and handle design for original approved by department head, and revise, rework or redesign as indicated, or carry through layout and detailing to completion for a manufacturer of office machinery. $6000–$7000. Illinois. R-6018.

PLANT MANAGER, chemical-engineering degree preferred, mechanical satisfactory, 35–45, extensive, high-level, practical plant-management experience. Knowledge of quality control and other factory operations encountered in light-manufacturing production process, knowledge of punch press and light machining, and production problems for a factory employing fifteen foremen and three to four hundred persons in a medium-sized town. Should be able to carry on in engineering-department office and shop. $9000–$12,000. Midwest. R-6033.

INDUSTRIAL ENGINEERS, 2, one experienced in mail order or retail with special emphasis on inventory control, merchandise-distribution office systems and methods. The other should have substantial background in mail order or in light manufacturing and warehouse work. Both positions require project-type industrial engineers working without close supervision to carry assignments through to completion. $6000–$7000. Illinois. R-6035.

MATERIALS-HANDLING CATALOGING STAFF, 30–40, mechanical or civil, with broad experience with materials-handling equipment and operation of supply systems (warehousing); knowledge of materials, supplies and equipment, and spare parts. Informed on use of such materials on large construction project. Will define, classify, and catalog these items. Previous experience as inspector on construction project or for manufacturing of equipment helpful. Willing to travel in or out of U. S. Ninety per cent desk work, for management company. $4800 and up. Headquarters, Illinois. R-6037.

(*ASME News continued on page 1080*)

NO "FREEZE-UP" with YARWAY TRAPS

Yarway Traps best the worst weather in this installation at Thermoid's Trenton plant.

Troubled with outdoor steam traps freezing? Solve the problem the way Thermoid did at their Trenton, N. J., plant.

They installed Yarway Impulse Steam Traps on coal handling equipment. Now, though temperatures dip to zero and snows pile high, their traps never freeze.

Condensate does not accumulate in Yarway Impulse Traps. The only moving part—a little valve—floats on the load. It discharges condensate as it comes through, instead of waiting for a quantity to accumulate. Hence —nothing to freeze.

Add to that, Yarway Traps' reputation for low maintenance, quick heating, easy installation, and economy of operation and you have reasons why over 600,000 Yarways have already been bought.

Often it costs less to install new Yarways than to repair old type traps. See your nearest Mill Supply Dealer. For his name, and free Yarway Trap Book, write . . .

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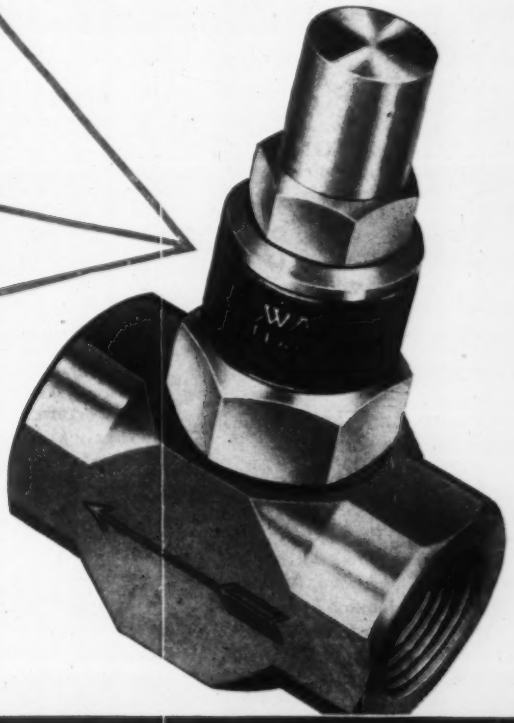


YARWAY IMPULSE STEAM TRAP

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Dec 25, 1949, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

AMBLER, HALFORD H., Winchester, Mass. (Rt)
AUSTIN, A. EARL, JR., Terre Haute, Ind.
BAILEY, D. P., Port Washington, N. Y.
BODLAENDER, HANS W., Long Island City, N. Y.
BOHANAN, LORRIS M., Compton, Calif.
BOTTIGGI, THEODORE A., Syracuse, N. Y.
BOURNE, JAMES G., Raleigh, N. C.
BRANDAU, FREDERICK L., Lakewood, Ohio
BRIND, ERNEST GOULD, Long Beach, Calif.
BROWNLEE, JAMES L., Birmingham, Ala.
BRUGNETTI, A. JOHN, Boston, Mass.
BRYANT, C. E., JR., New York, N. Y.
BUR, ARMAND, Cleveland, Ohio
BURKE, R. J., Hot Springs, Ark.
CARR, ALEX. B., Toronto, Ont., Can.
CHANG, DONALD, Vernon, Calif.
COLLETTE, JOHN B., Compton, Calif.
COLLIER, H. E., Cookeville, Tenn.
COPELAND, HOWARD R., San Francisco, Calif.
CORNELL, ELMER, Haddon Heights, N. J.
CREEK, R. W., River Forest, Ill.
D'ANTONI, BLAISE SALVADOR, JR., New Orleans, La.
DATH, GEORGE E., Mokena, Ill.
DOWNHAM, A. F., Boston, Mass.
EARL, GEORGE C., JR., Los Angeles, Calif.
EDWARDS, V. LEE, Detroit, Mich.
FACCIO, THEODORE L., Jackson Heights, N. Y.
FISHER, JOE J., San Pedro, Calif.
FLAGG, WALTER E., Boston, Mass.
FREEDMAN, RICHARD A., Buffalo, N. Y.
FRIEDERICK, GEO. R., San Rafael, Calif.
GIBIAN, PAUL B., Forest Hills, N. Y.
GOODMAN, LEONARD J., Detroit, Mich.
GREENE, ROBERT E., White Oak, Silver Spring, Md.
GRYNA, FRANK M., JR., Long Island City, N. Y.
GWOSDOW, MARTIN L., Richmond Hill, Ill.
HALLAHAN, J. T., New York, N. Y.
HARPSTER, W. C., Westfield, N. J.
HARRINGTON, ROBERT T., JR., New Haven, Conn.
HEILMAN, RICHARD L., Easton, Pa.
HELLMAN, G. A., Houghton, Mich.
HERNLUND, JOHN W., Chicago, Ill.
HOBART, ROBERT W., Johnson City, N. Y.
HOFFMAN, HUGH P., Palo Alto, Calif.
HOLDEN, FRANK C., Orono, Me.
IVINS, VERNON S., Drexel Hill, Pa.
JENSSEN, AXEL, Bound Brook, N. J.
JURY, MAURICE E., W. Allis, Wis.
KRUMMEL, KEVIN H., Brisbane, Queensland, Australia
KUEMMERLEIN, E. M., Wauwatosa, Wis. (Rt & T)
KURLAND, CHARLES, Fredonia, N. Y.
KURZ, GERHARD H., E. Orange, N. J.
LANGEVIN, LUCIAN C., Astoria, L. I., N. Y.
LEE, ALBERT K., San Francisco, Calif.
LEE, EVERETT WEBB, Worcester, Mass.
LEMON, CHARLES A., JR., Little Rock, Ark.
LOBERG, HARRY J., Ithaca, N. Y. (Rt & T)
MACDUFF, J. N., Seaford, N. Y.
MACKAY, SAMUEL L., Vancouver, B. C., Can.
MARCOVICI, HERMAN, Chicago, Ill.
MARKOVITS, JOSEPH A., Louisiana, Mo.
MERCER, SAMUEL, E. Lansing, Mich.
MESNARD, JAMES M., Albuquerque, N. Mex.
MITCHELL, ROBERT M., JR., Miami, Fla.
MOON, PAUL T., Chicago, Ill.
MOSS, CLIFTON L., 3D, Dallas, Texas
MUZICKA, ANTHONY, Troy, N. Y. (Rt & T)
NEAL, GLENN E., Canton, Ohio
OLMSTEAD, EDWIN H., Carlisle, Pa.
PATTON, KENNETH R., Ephrata, Wash.
PHAILBUS, THEODORE, Lahore, Pakistan, India
PHILIPS, OLIN H., Berwick, Pa.
PRENDERGAST, RICHARD EDWARD, Chicago, Ill.
RIEDIGER, HERMAN J. R., Roselle, N. J.
ROBBINS, DANIEL H., New York, N. Y.
ROOTHAM, WM. L., Toronto, Ont., Can.
RUFFLEY, JOHN H., Jersey City, N. J.
SANFORD, W. R., Oak Ridge, Tenn.
SASATI, ISKENDER, E. Chicago, Ind.
SCHADE, H. A., Berkeley, Calif.
SCHEFLOW, OLIVER WALLER, Rockford, Ill.
SCHEITHAUER, ELWOOD FAY, Hampton, Va.
SCHWARTZ, VARICK D., JR., Jeannette, Pa.
SELBY, DONALD W., Wilmington, Del.
SELMER, ALFRED P., Nanticoke, Pa.
SETO, JAMES, New York, N. Y.
SHAUB, JOHN E., JR., Lancaster, Pa.
SHAMES, IRVING H., College Park, Md.
STARR, WALDO E., Manhattan, Kan.
STILES, WM. B., Fayetteville, Ark.
STYS, Z. STANLEY, Erie, Pa.
TERRY, HOWARD P., New York, N. Y.
THACKER, J. E., Luton, Bedfordshire, England
THOMAS, LOYL R., Lawrence, Kan.
TILLOTSON, HENRY B., Minneapolis, Minn.
TRUMBULL, ROBERT G., Washington, D. C.
VANICK, JAMES SEBOLD, Westfield, N. J.
WACHT, RAYMOND JOSEPH, Pittsburgh, Pa.
WEBER, ARTHUR FREDERICK, Akron, Ohio
WEISER, FRANK, Gretna, La.
WITHERS, CARROLL E., Denver, Colo.
WOLF, EDGAR F., Baltimore, Md.
WOODBURN, JAMES D., Kansas City, Mo.
YOUNG, JOHN S., New York, N. Y.
ZULLIGER, A. F., JR., Oak Ridge, Tenn.

CHANGE IN GRADING

Transfers to Member and Associate

ALTORFER, HANS A., Oakland, Calif.
ANGELL, EUGENE N., Narrows, Va.
ARNETT, ROBERT R., Kokomo, Ind.
ASHWOOD, LOREN F., Hartford City, Ind.
BERGIN, ROBERT F., Garden City, Mich.
BLOUNT, THOMAS HARVEY, Morgantown, W. Va.
BRADY, SHERWOOD J., San Jose, Calif.
BROWN, F. A. J., Lancaster, Pa.
BROWN, GEORGE I., Cincinnati, Ohio
CHESTERS, FRANK C., Lancaster, Pa.
CHRISTOPH, OTTO K., Rio de Janeiro, Brazil, S. A.
CONDON, WILLIAM F., 3D, Watertown, Mass.
COOK, MARSDEN A., Troy, N. Y.
CRAFT, HARRY WILLIAM, St. Louis, Mo.
CRANE, ALBERT, Los Angeles, Calif.
CUMMING, HERBERT A., Maywood, N. J.
ELY, ROBERT E., Richland, Wash.
FOSHOLT, S. K., Muscatine, Iowa
FRAME, JOHN S., JR., Philadelphia, Pa.
GARRETT, EDWARD J., New York, N. Y.
GILBERT, HAROLD MAIER, Corning, N. Y.
GOGLIA, MARIO J., Atlanta, Ga.
GRUBELICH, MATTHEW J., Plainfield, N. J.
HANNUM, CHARLES M., Detroit, Mich.
HUNG, CHAN BING, Kowloon, Hong Kong, China
KERSHNER, STUART G., Houston, Texas
LEVINE, BERNARD, Dayton, Ohio
MALISCHKE, CARL, Wauwatosa, Wis.
MANTHEI, E. C., Champaign, Ill.
MAKI, EINO E., Waukegan, Ill.
MILLER, BURTON RICH, Mishawaka, Ind.
MILLER, WILLIAM H., Memphis, Tenn.
MOSES, RICHARD, Charleston, W. Va.
OERGEL, CHAS. T., Middle Valley, N. J.
PARKS, WILBUR H., Denver, Colo.
ROBINSON, JAMES M., Hornell, N. Y.
ROMANCHUK, PETER A., North Bergen, N. J.
RUZGA, JOSEPH A., Baltimore, Md.
SAYER, JOHN S., Linthicum Heights, Md.
SKORTZ, A. C., Edgewater, Md.
SMITH, L. CHEYNEY, JR., Paterson, N. J.
SOROUR, EL-SAYED A., Guiza, Egypt
THOMPSON, JOSEPH C., New York, N. Y.
WEISER, EARLE PHILIP, Medford, Ore.
WILSON, JOSEPH G., New York, N. Y.

Transfers from Student Member to Junior 104

Obituaries

Walter Rowland Bell (1900–1949)

WALTER R. BELL, vice-president in charge of sales, Ingersoll-Rand Co., New York, N. Y., died at his home in New York on Sept. 8, 1949. Born, Hoboken, N. J., July 8, 1900. Parents, William Henry and Lucy (Watts) Bell. Education, Webb Institute of Naval Architecture. Married Ann Thompson, 1946. Jun. ASME, 1926. Survived by wife.

Edward Joseph Calnan (1901–1949)

EDWARD J. CALNAN, superintendent, steam plants for the Ontario Paper Co., Ltd., Thorold, Ont., Can., at all the divisions, died in an airplane crash, September, 1949. Born Vernonville, Ont., Can., Feb. 4, 1901. Education, BS, University of Toronto, 1928. Married Lydia Upton. Jun. ASME, 1930. Survived by wife, son, Joseph, and daughter, Madeline.

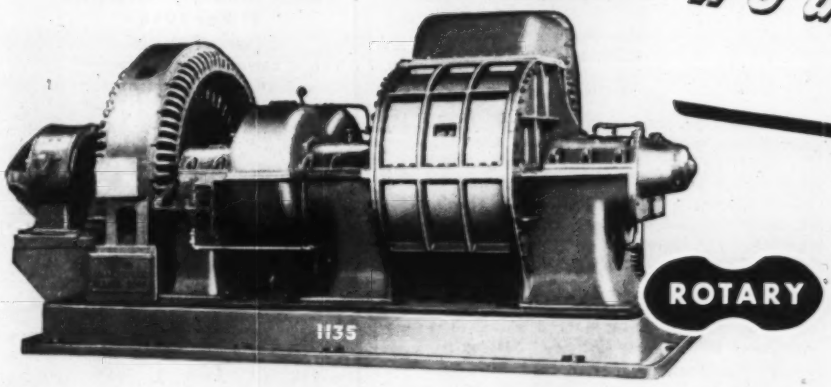
Vincent Morse Frost (1880–1949)

VINCENT MORSE FROST, mechanical engineer

(*ASME News continued on page 1082*)

One of a battery of three type H, multi-stage R-C Centrifugal Blowers; each direct-coupled to 700 HP motor; capacity of each blower is 15,000 CFM.

Freedom of choice WITH *R-C dual-ability*



R-C Rotary Positive Blower, variable speed, 400/200 RPM; capacity is 12,000 CFM.

You're not confined to just one type of blower or exhauster when you bring your air or gas handling questions to us. That's because we build both Centrifugal and Rotary Positive units. You can specify the equipment best suited to the specific job. We are the only blower manufacturer offering this *dual choice.*

R-C *dual-ability* delivers other advantages. Our extensive lines of Centrifugal and Rotary Positive types enable you to match capacities, pressures and other characteristics closely to your requirements—resulting in economies both in first cost and in operating cost.

You can bank on the performance of R-C Blowers, too. Building equipment for handling air and gas has been our only business for almost a century—so we *must* give complete satisfaction to every customer.

ROOTS-CONNERSVILLE BLOWER CORPORATION
912 Michigan Avenue, Connersville, Indiana

FOR HANDLING GAS OR AIR, CALL ON *R-C dual-ability*

Roots-Connersville builds the most extensive line of gas or air handling equipment.

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★ ★ ★ ★ **ROOTS-CONNERSVILLE** BLOWER BUILDERS R-C SINCE 1854 ★ ★ ★ ★

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★ ★ **ONE OF THE DRESSER INDUSTRIES** ★ ★

for 36 years with Public Service Gas and Electric Co., Newark, N. J., died Sept. 30, 1949, at East Orange (N. J.) General Hospital. Born, Cleveland, Ohio, July 30, 1880. Parents, Albinus F. and Emma (Richardson) Frost. Education, BSME, Harvard University, 1902. Married Emily A. Randall, 1905; children, Alice Emily, Jessie Hall, Benjamin Randall, Doris Richardson, Vincent Morse, Jr. Mem. ASME, 1914. Served in various capacities on many of the committees of the Research and Power Test Code Committee, Boiler Code Committee, and Standards Committee. He was treasurer, ASME Metropolitan Group, 1937–1938. Survived by wife, two sons, Benjamin R. and Vincent M., Jr.; and two daughters, Mrs. Joseph Vigerstad and Mrs. William R. Francis; three brothers, Royal H., Ira C., and Francis L.; and two sisters, Mrs. Louis C. Brown and Miss Emma Frost.

Charles Hubbard Hill (1869–1949?)

CHARLES HUBBARD HILL, whose death was reported to the Society, was a designing engineer. Born, West Troy (now Watervliet), N. Y., Sept. 20, 1869. Education, Troy Academy; Rensselaer Polytechnic Institute. Assoc. ASME, 1907.

Domenick Joseph Iorillo (1914–1949)

DOMENICK J. IORILLO, mechanical engineer, Fletcher-Thompson, Inc., Bridgeport, Conn., died July 24, 1949. Born, Rye, N. Y., Nov. 28, 1914. Parents, Pompilio and Mary (Riccio) Iorillo. Education, ME, Rensselaer Polytechnic Institute, 1936. Married Ann C. Gormley. Jun. ASME, 1936.

Herman Louis Kutter (1872–1949)

HERMAN LOUIS KUTTER, director, The Black-Clawson Co., Hamilton, Ohio, died March 3, 1949, at his home in Hamilton. Born, Lindau, Bavaria, Germany, July 12, 1872. Parents, Ludwig and Marie (Schwartz) Kutter. Education, Royal Gymnasium, Hirschberg, Lower Silesia, Prussia. Naturalized citizen, U.S.A., 1896. Married Florence Kennedy, 1894. Held many patents relating to paper machinery. Jun. ASME, 1902; Mem. ASME, 1906. Survived by wife.

Henry Mabbett Mathews (1907–1949)

HENRY M. MATHEWS, superintendent, City of Thomasville (Ga.) Water and Light Department, died Aug. 12, 1949. Born, Quitman, Ga., Jan. 15, 1907. Parents, Wallace and Hazel (Mabbett) Mathews. Education, Georgia Institute of Technology. Jun. ASME, 1934.

Frederick Mills (1897–1949)

FREDERICK MILLS, chief mechanical engineer, Western Australian Government Railways, Midland Junction, Western Australia, died June 22, 1949. Born, Newcastle-on-Tyne, England, 1897. Education, Rutherford Technical College, Newcastle-on-Tyne. Assoc.-Mem. ASME, 1928; Mem. ASME, 1935.

Fritz Alfred Ernest Neuhaus (1872–1949)

FRITZ A. E. NEUHAUS, consulting engineer, Creve Coeur, Mo., died Sept. 9, 1949. Born, Berlin, Germany, Jan. 14, 1872. Education, Technische Hockschule, Charlottenburg, Germany. Jun. ASME, 1898; Mem. ASME, 1906.

Charles Trescott Ripley (1886–1949)

CHARLES TRESCOTT RIPLEY, retired chief engineer, Wrought Steel Wheel Industry, Chicago, Ill., died Feb. 6, 1949, at his home in South Laguna, Calif. Born, Oak Park, Ill., April 20, 1886. Parents, Joseph Perce and Harriet (Konantz) Ripley. Education, BSEE, 1909, and ME, 1912, University of Illinois. Married Mabel Thompson, 1918; children, Charles Purcell, Barbara Anne, and Trescott. Mem. ASME, 1929; Fellow ASME, 1945. Served on the Committee on Medals, Railroad Division, and Professional Division. He is survived by wife and three children.

Joseph Linus Schlitt (1895–1949)

J. L. SCHLITT, section chief, research and engineering department, Liquefaction Division, Air Reduction Co., New York, N. Y., died April 29, 1949. Born, Commerce, Mo., March 1, 1895. Parents, Fred and Johanna (Hemmrich) Schlitt. Education, ME, University of Missouri, 1917. Married Emily Quinn, 1927; daughter, Merylin Anne. Jun. ASME, 1919; Mem. ASME, 1941.

William Henry Shields (1885–1949)

WILLIAM HENRY SHIELDS, division manager, Southern Division, The Texas-Empire Pipe Line Co., Tulsa, Okla., died of carcinoma of the liver at St. John's Hospital, Tulsa, Aug. 27, 1949. Born, Oil City, Pa., March 26, 1885. Parents, Hugh and Alice (Weighbright) Shields. Education, graduate, Oil City (Pa.) High School; ICS. Married Margaret Gahan, 1922. Assoc.-Mem. ASME, 1931; Mem. ASME, 1935. Survived by wife.

Ross William George Taylor (1891–1949?)

ROSS W. G. TAYLOR, whose death was recently reported to the Society, was assistant engineer, Hydro-Electric Power Commission of Ontario, Toronto, Ont., Can. Born, Toronto, Ont., April 14, 1891. Education, BASc, University of Toronto, 1912. Mem. ASME, 1939.

Daniel Goodwin Thompson (1906–1948)

DANIEL GOODWIN THOMPSON, superintendent, Heating Device Division, General Electric Co., Bridgeport, Conn., died while at his desk of a coronary occlusion on Nov. 9, 1948. Born, Chester, Pa., July 15, 1906. Parents, Thomas Wilson and Edith (Topping) Thompson. Education, graduate, West Chester (Pa.) High School. Married Lily May Collins, 1932. Jun. ASME, 1931. Survived by wife and daughter, Joan Topping Thompson.

Ross S. Wallace (1869–1949)

ROSS S. WALLACE, former president and chairman, board of directors, Central Illinois Light Co., Peoria, Ill., died Aug. 28, 1949, at his home following a protracted illness. Born, Chatsworth, Ill., Dec. 9, 1869. Parents, Robert and Louise (Strawn) Wallace. Education, BSME, University of Illinois, 1891. Married Jessie Waring, 1898. Mem. ASME, 1904. Survived by wife, three daughters, Mrs. Margaret W. Crawley, Flint, Mich.; Mrs. Helen W. Younge, Peoria, Ill.; Mrs. Eleanor W. Strong, Newton Center, Mass.; two sisters, Miss Lucille Wallace and Mrs. Frances Revenaugh, both of Pontiac, Ill.; and six grandchildren.

Jay L. White (1922–1948)

JAY L. WHITE, factory manager of a plant manufacturing paint brushes, died in Scarborough, N. Y., Nov. 20, 1948. Born, Ossining, N. Y., May 28, 1922. Parents, Harry and Rebecca White. Education, BSIE, Columbia University, 1948. Jun. ASME, 1948. Survived by parents.

James Joseph White, Jr. (1889–1949)

JAMES J. WHITE, JR., founder and president of James J. White, Inc., Philadelphia, Pa., piping and plumbing contractors, died Sept. 19, 1949, at his summer residence in Margate City, N. J. Born, Philadelphia, Pa., Nov. 11, 1889. Parents, James Joseph, Sr., and Rose A. White. Education, Normal School; Pierce Business College. Married Mary Fagan, 1914. Mem. ASME, 1941. Survived by wife, a son, James J., 3rd; and three daughters, Mrs. Jeremiah J. Sweeney and the Misses Rosemary L. and Virginia F. White.

Harold Ward Wickstrom (1898–1949)

HAROLD WARD WICKSTROM, consulting engineer, Los Angeles, Calif., died July 7, 1949. Born San Francisco, Calif., May 5, 1898. Parents, Lawrence and Josephine (Ward) Wickstrom. Education, ME, University of California, 1920. Married Marion McEneany, 1921. Mem. ASME, 1945. Mem. Svenska Uppfinnare Föreningën, 1946. Survived by wife and three children, Maryanne, Thomas Lawrence, and Catherine Ward Wickstrom.

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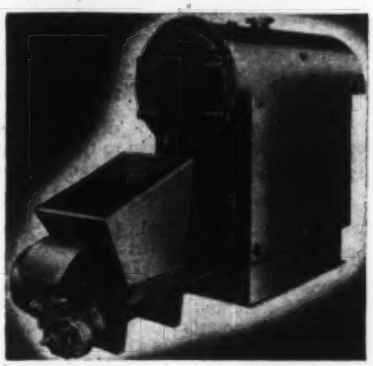
• NEW EQUIPMENT

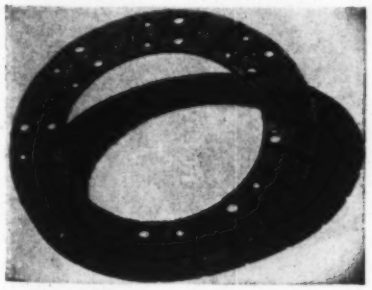
New Boiler-Stoker Unit



"Unitbilt" Combinations in ten sizes, with steam radiation capacities of 2,190 to 8,500 sq. ft., are announced by The Brownell Co., 446 N. Findlay St., Dayton 1, Ohio. The stoker ironwork is factory-installed in the boiler furnace. After the boiler has been set on location, the stoker driving mechanism is readily connected. Obviously, pre-installation of the hearth and retort greatly simplifies the final assembly work and reduces the installation time and expense. Cleanout doors are provided in the front and rear of the base. Both stoker and boiler are Brownell products, fixing entire responsibility upon a single manufacturer. "Unitbilt" Boiler-Stoker Combinations are illustrated and described in Bulletin No. SF-1 which will be gladly sent upon request.

Clutch Facing

New York—"S-W" Facing is a new clutch facing developed by the Johns-Manville Research Laboratory and now available nationally.

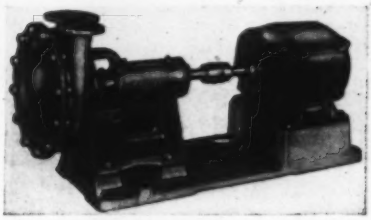


This new "S-W" (Spiral Wound) Facing is made of asbestos-metallic yarns and is the product of new manufacturing techniques which make it possible to match the specific clutch action of any clutch design. This facing offers a flexibility desirable in handling during installation. Other advantages include: less variations in torque under a wide range of temperature and load conditions; minimum chatter in all engagements—forward or reverse; longer, trouble-free life and improved "cushion" clutch action in service.

"S-W" Facing has the lowest rate of wear combined with excellent quality and appearance. Its "eye-appeal" is distinctive. Not only is the winding of the asbestos-metallic yarn close and uniform, but also, through improved factory-precision molds, the edges are clean and smooth.

The quality of this Johns-Manville Spiral Wound facing is controlled in all stages of its manufacture from the raw asbestos to the finished product. All points of quality and performance have been proved under exhaustive laboratory and road tests.

Goulds Announces a New Line of Stainless Steel Pumps



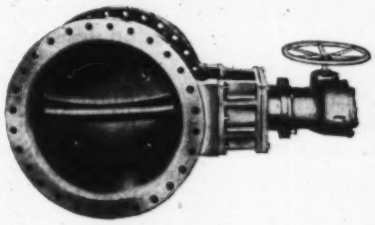
Goulds Pumps, Inc., Seneca Falls, New York, announce the addition of Stainless Steel pumps to their line of industrial pumps.

The new pumps are the result of several years of development and represent the last word in advanced design. They are engineered to give dependable, efficient service in the handling of corrosive liquids.

Sizes: Available in 8 sizes with capacities up to 750 G.P.M. and heads up to 180 ft., depending on capacity.

For more information: Send for Bulletin 725.3 for complete details and performance curves.

Rubber Lined Valve



New "Type No. 709" is a 30-inch 50-pound cast iron valve equipped with 125-pound flanges and a renewable one-piece rubber seat for positive shut-off. Valve is air bubble tight at 80 psi and drip tight with water at 100 psi. Used efficiently in the temperature range from minus 20° to plus 200°F. Because the valve shaft moves only with an oscillating motion, there is no packing difficulty. Special handwheel control has a fully enclosed gear reduction drive. Easily adapted to automatic control.

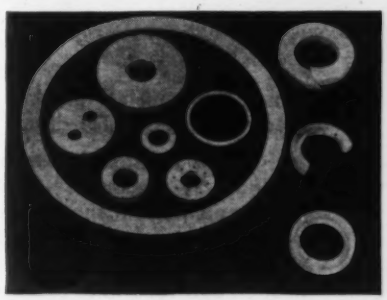
Available in smaller or larger sizes, in all materials and for higher pressures. R-S Products Corp., Wayne Junction, Philadelphia 44, Pa.

Giant Air Heater

More than thirty miles of 2-1/2-inch steel tubing have gone into the giant air heater shown under construction in the Chattanooga, Tenn., shops of Combustion Engineering-Superheater, Inc. The weight of this tubular-type air heater for the Central Arizona Power & Light Co., Phoenix, is 45 tons, and it is 17 feet deep, 32 feet wide and 52 feet high. Total effective heat-transfer area for its 3550 tubes is nearly 105,000 square feet. When completed it will form part of an outdoor steam generating unit, having a capacity of 675,000 pounds of steam per hour at 920 psig and 905 F total temperature.

Molded Chemlon Is Available

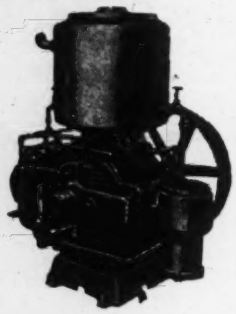
The Crane Packing Co. of Chicago has announced that its new chemically inert packing material, Chemlon, is now available in molded form in a wide variety of shapes.



In the new molded form, Chemlon retains all of the chemically inert properties of the familiar braided packing. It is not attacked by any acids or alkalis, and stands up for long periods of time under conditions never before successfully sealed by packing. It is effective to temperatures of 450° F. The

Continued on Page 42

here's help for HIGH VACUUM problems



Beach-Russ Type RP Single Stage Vacuum Pump. Capacity—17 to 845 c. f. m.

For low pressure wet or dry processes, electronic testing, packaging, mechanical or other vacuum applications, these pumps offer efficient, quiet, power-saving performance with minumum maintenance. These positive rotary, automatically lubricated pumps test to absolute pressures as low as ten microns.

BEACH-RUSS *high vacuum* PUMPS

Write for Catalog No. 84

BEACH-RUSS COMPANY
58 Church St. New York 7, N. Y.

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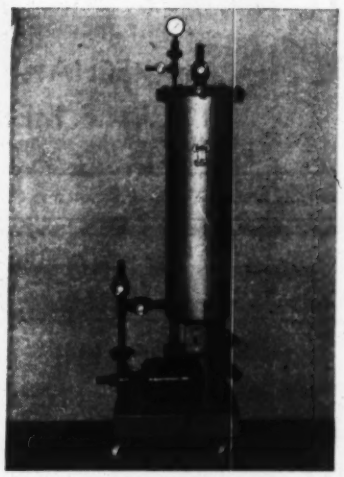
special molding process developed by the manufacturer results in very high flexibility. This is particularly helpful in installation of the packing rings. When split, they can be twisted and placed directly on the shaft without the necessity of completely removing the gland. Another feature of Chemlon molded styles is the exceptional electrical properties of the material. Its combination of low power factor and low dielectric constant makes it an excellent insulator for high frequency transmission lines where low loss is a rigid necessity.

Among the many molded forms now furnished are washers, bushings, rings, self-sealing "V" cross section rings, ring gaskets, and jacketed (French) gaskets. Numerous special shapes can also be molded for individual requirements. Further information may be obtained by writing the manufacturer, Crane Packing Co., 1814 Cuyler, Chicago, Ill. If, in Canada, write: Crane Packing Co., Ltd., 122 Wellington St., North, Hamilton, Ontario. A special booklet describing Chemlon and other Chemical packings will be furnished on request.

Kneaded Rubbers

Excellent for removing or highlighting chalks and charcoals. As a cleaner over drawing boards and tracing cloths and even delicate surfaces they are highly recommended. "Kneaded Rubbers" contain no abrasives—they are of the plastic family; they absorb dirt rather than rub it into the plane. "Kneaded Rubbers" can be formed into any desired shape. They are soft and exceedingly pliable. Write for free sample to Eberhard Faber Pencil Co., 37 Greenpoint Ave., Brooklyn 22, N. Y.

Low-Cost Filter Units



Production of a series of new, low-cost filter units, especially adapted to the filtering of light solutions, has just been announced by Titeflex, Inc., 500 Frelinghuysen Ave., Newark, N. J. Designated as the SFN series, the new units contain all of the features of regular Titeflex filters, but are produced at minimum cost. They require no replacement parts such as bags, pads, etc. Filtering is accomplished by filter-aid supported by rigid membranes of wire mesh or porous stone. A few cents worth of filter-aid handles each batch filtered. In addition, the new units are cleaned by a backwash system, without taking the machine apart and without handling the sludge in any way. Waste labor is entirely eliminated. Available in plain steel, rubber-lined steel and Type 316 stainless, these filters operate efficiently with both cyanide and acid solutions. Chamber capacities are: One sq. ft. (delivers 400 g.p.h. open pumping); three sq. ft. (delivers 560 g.p.h.); $4\frac{1}{2}$ sq. ft. (delivers 1,020 g.p.h.); and nine sq. ft. (delivers 2,280 g.p.h.). Standard equipment includes filter chamber, pump, motor, motor starter and all valves and fittings, assembled on a portable platform. Precoat tanks can also be supplied at slight extra cost. Full information and prices will be supplied by the manufacturer upon request.

DENSE, POROSITY-FREE WELDS..

. . . Welding of Exchanger 16" × 5'0" long with HELIARC. By this method, *very dense, porosity-free* welds can be produced in metals (aluminum, everdur, etc.) that previously gave some difficulty in welding.

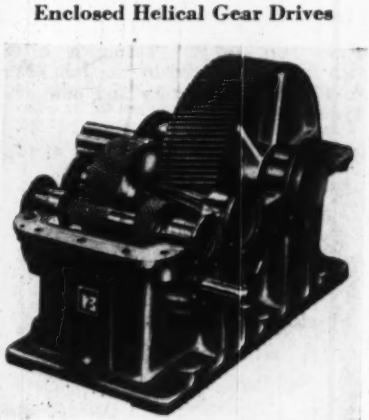
We of DOWNINGTOWN, solicit your inquiry for heavy duty shell and tube equipment:

Alloy materials, including aluminum, inconel, nickel, phosphor bronze, or welded copper. Many of these are welded by Heliarc. Bimetal and finned tube jobs, to our own performance designs. Impregnated graphite jobs for very high corrosion resistance. Special stainlesses, for difficult service conditions.

Design and construction meet standard of A.S.M.E. or other agency specified by customer. All equipment of our design is sold on a guaranteed performance basis. We also fabricate to customer's drawings. Modern facilities available for checking welding operations by X-RAY. Write on your letterhead for DOWNINGTOWN literature on shell and tube heat exchangers.

DOWNINGTOWN IRON WORKS
DOWNINGTOWN, PA.
HEAT EXCHANGERS

Enclosed Helical Gear Drives



Foote Bros. Gear & Machine Corp., 4545 Western Blvd., Chicago 9, Ill. has just released a 16-page Engineering Manual, MPA, on their new line of Maxi-Power Enclosed Helical Gear Drives. It contains complete ratio information, horsepower rating tables, simplified selection procedure,

• Keep Informed

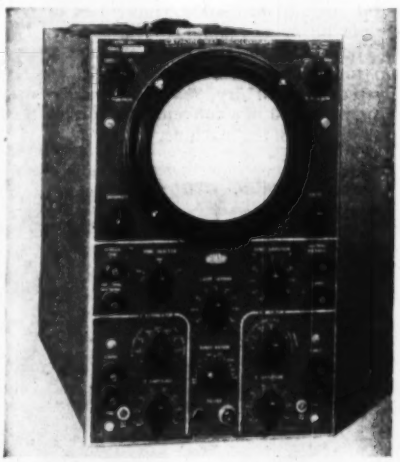
overhung load capacities, assembly diagrams, dimensions and weights of single, double and triple reduction units.

Features of this new line of speed reducers include improved accuracy of gear tooth generation, higher quality materials, improved heat treatment, closer manufacturing tolerances, reinforced housing design and many other improvements that permit the selection of a smaller size, lower weight unit than was previously possible.

Maxi-Power drives are available in 42 sizes with standard ratios ranging from 2.08 to 1 up to 360 to 1. Capacities range up to 1,550 horse power.

Du Mont Announces New Types 304 and 304-H as Successors to the Type 208-B

Two new instruments, the Du Mont Types 304 and 304-H Cathode-ray Oscillographs, were announced recently as replacements for the famous Type 208-B Cathode-ray Oscillograph by Allen B. Du Mont Laboratories, Inc., Clifton, N. J. The new Types 304 and 304-H contain all the features that made the Type 208-B the most popular cathode-ray oscillograph in the world, plus many more, wholly new to the low-priced field. Except for the somewhat higher accelerating potential of the Type 304-H, the Types 304 and 304-H are identical.



Stable, high-gain a-c and d-c amplifiers are provided for both X and Y axes. Due to the unique circuit design, instantaneous recovery from signal overload is assured, even at high gain.

Recurrent and driven sweeps are variable from 2 to 30,000 cycles per second. Through an ingenious arrangement of switches, extremely slow sweeps, of 10 seconds or more, are available by the connection of external capacitors between the X-input terminals on the front panel.

Vertical deflections on these instruments may be expanded to four times full-screen diameter; horizontal deflections, to five times full-screen diameter. Positioning controls have sufficient range that any portion of a fully expanded pattern may be centered on the screen, with no on-screen distortion present.

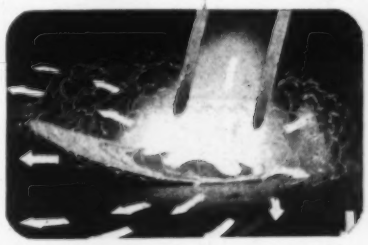
Stabilized synchronization of the pattern is maintained in the Types 304 and 304-H by a sync-limiting circuit, so the sweep length and synchronization are unaffected by variations in signal voltage level.

In the Type 304, the cathode-ray tube is operated at an overall accelerating potential of 1780 volts. In the Type 304-H, an additional intensifier power supply increases this

Continued on Page 44

How can you cut costs with ARC WELDING?

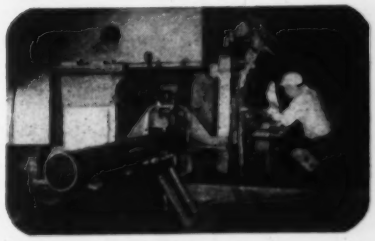
See this film and find out!



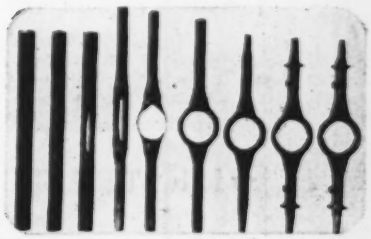
1. **"ARC WELDING AT WORK"**, a 16mm full-color motion picture produced by General Electric, has a message for every cost-conscious executive who may be overlooking opportunities for arc welding in his own plant. A vivid animated treatment (above)...

2... makes the technical parts of this film highly palatable. New uses for arc welding are suggested throughout. Welded building construction, for example (above) is shown to be efficient and economical. And as outdoor pressure vessels and piping...

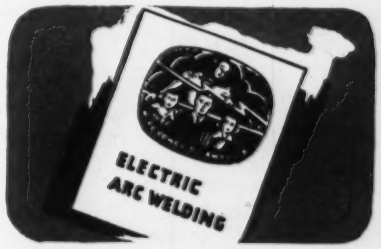
3... become larger and more complicated the value of modern arc welding becomes more and more evident. In fabricating a consumer product like kitchen sinks (above), the film shows how high-quality welding adds extra eye appeal and salability.



4. As exemplified in this tubing machine (above) automatic arc welding is shown to offer almost limitless opportunities. Here, precise heat control is the big factor. Also, arc welding provides highly ductile joints, a fabricating requirement for...



5... this automotive rear-axle housing (above). These welded joints withstand ten severe stretching and swaging operations, with no sign of failure! Because we believe you can profit from a wider knowledge of arc welding, let us send you this...



6. **ARC WELDING MANUAL... FREE!** It has all the data you need to make an intelligent decision on this vital subject. [The complete program consists of a 30-minute film, manual and "highlights" booklets.] MAIL THE COUPON TODAY!

FREE *to business management!*

General Electric Co., Section C684-13
Schenectady 5, N. Y.

Attach to your business letterhead

☐ Please send me a complimentary copy of the G-E Arc Welding Manual (GES-3491). (Extra copies at regular manual price—$1.25.)

☐ I'd like to borrow a 16mm print of the color film from my nearest G-E office.

Name_____ **Title**_____

Company_____

Street_____

City_____ **State**_____

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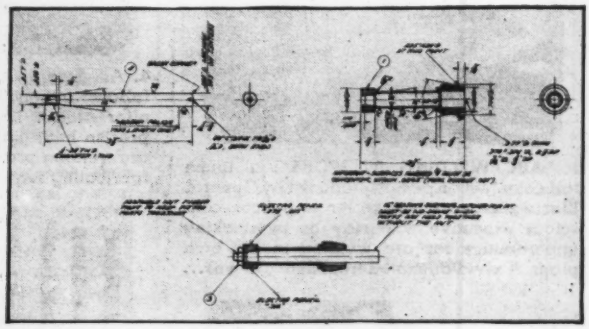
with STEEL — the small extra first cost of test samples pays off in assurance of efficiency and durability of the finished product.



with TRACING CLOTH . .

The small extra first cost of Arkwright Tracing Cloth, over that of tracing paper, repays many times over in the efficiency and durability of valuable drawings.

Your investment in Arkwright Tracing Cloth is a trifling sum, compared to its returns in drawings kept permanently sharp and repeatedly useful!

Foresighted drafting departments regularly specify fine-woven, expertly bonded Arkwright, rather than perishable tracing paper, for *every drawing worth keeping for possible future use.*

Read the *Big Six Reasons* why Arkwright Tracing Cloth eases work, improves jobs, resists wear and time. Then send for generous samples and prove this superiority on your drawing board. Sold by leading drawing material dealers everywhere. Arkwright Finishing Company, Providence, R. I.

The Big Six Reasons Why Arkwright Tracing Cloths Excel

1. Erasures re-ink without feathering.
2. Prints are always sharp and clean.
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potential to 3000 volts. The higher accelerating potential of the Type 304-H facilitates the use of long-persistence screens so that fullest possible advantage may be taken of the slow recurrent sweeps, the high-speed driven sweeps, and the d-c amplifiers of the instrument. Writing rates as high as 2.8 inches per microsecond may be photographed from the screen of the Type 304-H using the Du Mont Type 314-A Oscillograph-record Camera with an f/1.5 lens.

In every dimension the Types 304 and 304-H are smaller than the Type 208-B, making them even more portable than was their predecessor.

For additional information concerning the new Du Mont Types 304 and 304-H Cathode-ray Oscillographs, write the Instrument Division, Allen B. Du Mont Laboratories, Inc., 1000 Main Avenue, Clifton, N. J.

New, Versatile Model of Bruning Whiteprinter

A new and versatile model has just been added to the well-known line of Bruning Whiteprinters. It is known as the "Model 50." It provides a quick, efficient way to make reproductions of anything drawn, typed, printed, or written. The Model 50 has a capacity normally to be expected only in much more expensive machines. It is designed to fit the requirements of users who need a compact Whiteprinter capable of producing up to 10,000 square feet of BW Prints during an ordinary working day.

The Model 50 operates at variable speeds up to 24 feet per minute. Prints are delivered flat and dry, ready for instant use, neatly stacked in a convenient receiving tray on the front of the machine.

Like all Bruning Whiteprinters, the operation of the Model 50 is odorless. It requires no plumbing connections or ventilation ducts. There is nothing to interfere with locating the Model 50 conveniently in the plant or office anywhere that the necessary current is provided.

The Model 50 produces BW Prints ranging from postcard size to 42 inches wide and any length. Users have their choice of BW Sensitized Paper, Film and Cloth in the forms of cut sheets and roll stock.

The Model 50 produces clean sharp prints. Each finished BW Print looks like the original, with black or colored lines on a white or tinted background. These prints are easy to read and handle. Revisions and notations can readily be made on BW Prints. Tests prove that dark lines against a light background are more legible and understandable to the average individual than white lines on a dark background—such as blueprints.

Although the most popular BW Prints have black lines on white, the Model 50 can produce BW Prints in 20 combinations of colored lines and tinted paper. This versa-

• Keep Informed

tility permits simple color keying—a practice which is very helpful in identifying the purpose of a print. For example, experimental prints can be shown on pink paper, approved prints on yellow, etc

The new Model 50 produces prints directly from the original without intermediate steps. There are no stencils, special masters, or film negatives. All chance for error from manual transcription is eliminated. No checking or proofreading is needed, and much time is saved.

Engineers find the Model 50 ideal for making BW Prints of mechanical drawings, working drawings, specifications, charts, plats, work orders, bulletins, handbook revisions, etc. Businessmen use the Model 50 for copying correspondence, office forms, reports, financial records, invoices, sales data, etc. Design of the Model 50 is so simple that any girl can operate it without training. Descriptive literature on the Model 50 and the BW Process is offered to interested readers at no obligation. Simply write, requesting your free copy of Bulletin A-1063, to the Charles Bruning Co., 4754 Montrose Ave., Chicago 41, Ill.

Yale & Towne Announces New Pak-Loader Fork Truck System

Boxes, barrels, bales, drums, and cartons can now be handled in multiple units, without the use of pallets, by the application of the new Yale & Towne Pak-Loader Fork Truck System.

The System is most advantageous: (1) where large quantities of goods are stored, and (2) when goods are customarily shipped unpalletized.

Where large quantities of goods are stored, the System saves thousands of dollars since it does away with pallets.

The System eliminates handling operations and saves work-hours when pallets are not to be shipped with the load, as loads comprising many individual containers are pushed into position on freight cars or highway trucks in one operation, whereas pallets would have to be unloaded one container at a time.

The above two comparisons bring out advantages in addition to the now well known savings made possible by handling goods as unit loads (i.e. many packages at once) rather than handling each package individually.

The Pak-Loader Fork Truck System comprises two components, namely fork trucks equipped with pusher mechanisms and two or three specially adapted steel plates per fork truck.

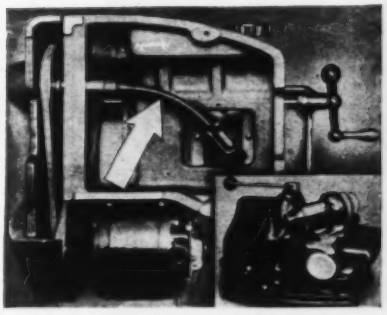
The steel plates are cut to the size which best fits the specific load to be handled. Legs about four inches high are secured to one end of the plate. When loading the plate, a block of wood is placed under the toe to keep it level. The forks of the truck slip under the plate for lifting. When unloading, the forks are tilted forward to rest

Continued on Page 46

S.S. White

FLEXIBLE SHAFTS SIMPLIFY DESIGN

This Flexible Shaft Drive Permits Adjustment of Driven Part



In this valve grinding machine, it was desired to make provision for three-way adjustment of the power driven chuck. This was easily accomplished with a single basic mechanical element by using an S.S.White flexible shaft, as shown.

Photo courtesy of Van Norman Machine Co., Springfield, Mass.

FOR driving or controlling parts which require adjustment in operation, there's nothing like S.S.White flexible shafts. They are smooth operating, dependable and adaptable to a wide range of design and operating conditions. They come in a large selection of sizes and characteristics, made up to your specific length requirements and ready for easy coupling to driven or controlled parts.

FREE—FLEXIBLE SHAFT HANDBOOK

S.S.White MAKES IT RIGHT

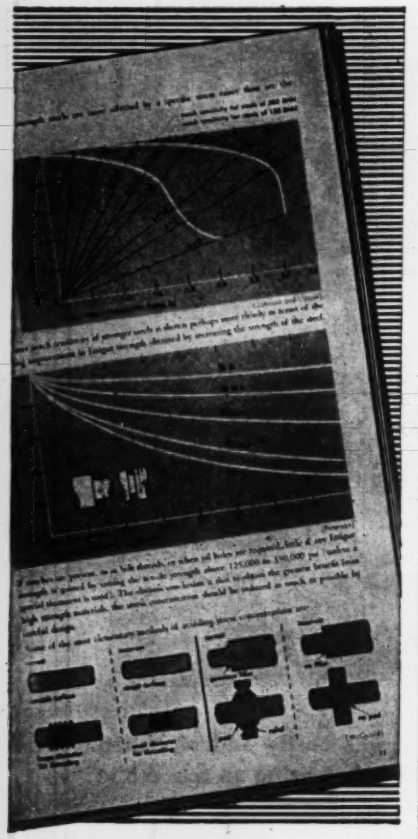
260 pages of facts and data on flexible shaft application and selection will be sent on request if you write for it on your business letterhead and mention your position.

S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO. — DEPT. L, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS AND ACCESSORIES
MOLDED PLASTICS PRODUCTS—MOLDED RESISTORS

One of America's AAAA Industrial Enterprises



Every designer must be something of a metallurgist

Here are 72 pages packed with information of vital significance to engineers faced with the design, selection and treatment of steel components to give a specified service at minimum cost.

Besides dealing with scientific design, the book gives important metallurgical data, all compiled from the designer's viewpoint. Free on request.

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MOLY

MR-12 F22

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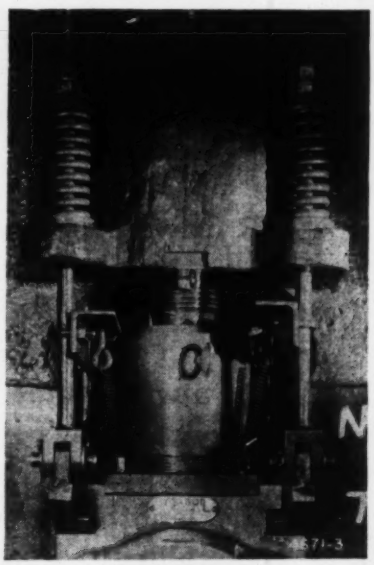
the front end of the loaded plate next to the pile of goods already stored. As the pusher is extended, the truck moves backward. A locking device holds the steel plate on the forks and prevents it from being pushed off with the load. The plate is returned for reloading when the truck picks up another load. While the truck is taking a load to storage, or from storage to shipping, another plate is being loaded in readiness for the truck's return.

The truck, of course, can be used as a regular fork truck for handling skids and pallets when both pallet (or skid) and non-pallet non-skid operations are employed. For complete information on the new system write to The Yale & Towne Mfg. Co., Philadelphia Div., Roosevelt Blvd. & Haldeman Ave., Philadelphia 15, Pa.

Load Weighing Cells

Continual indication of loads or forces of 100 tons or more, applied by mill rolls used for making materials as varied as sheet steel and paper, or for applying coatings on sheet materials, has been made practicable by the use of load-weighing cells in which SR-4 bonded resistance wire strain gages are the load sensitive elements.

These load cells have the essential advantages of being small in size and having a deflection under load that is imperceptible except to an electronic amplifying circuit. They can be designed in various forms to fit existing mills.

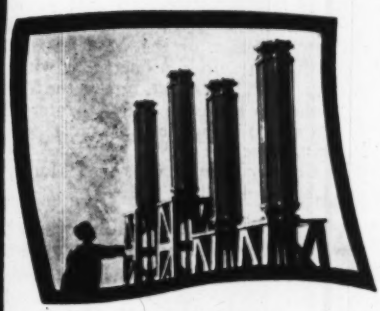


Basically, a load cell consists of a short steel column on which SR-4 resistance wire strain gages are bonded. Changes in the resistance of the strain gages, caused by compression of the column, are automatically translated into pounds or tons which are indicated by a pointer on a circular scale. A recorder can also be used. Both the gages and load cells are manufactured by The Baldwin Locomotive Works, Philadelphia 42, Pa., and are now used on numerous rolling mills in several industries.

There are several reasons in addition to those mentioned above for using these load cells on rolling mills. They enable closer control of the uniformity of gage of sheet and strip steel than was possible before, it was reported at one of the major steel companies plants where six 200,000-lb. capacity load cells were recently installed on the tandem cold rolling mill illustrated. This advantage is especially true of tandem mills because uniformity of stock after each reduction con-

Ledeen heavy duty cylinders helped do this job better

OPERATING
REFINERY
GATE VALVES



APPLICATION—The 8" diam. x 36" stroke Ledeen heavy duty cylinders, illustrated here, are used to operate 24" and 30" diam. gate valves carrying hot oil. Refinery layout makes remote control necessary. Controlled from the central point Ledeen cylinders provide instant and easy action of all gate valves.

INSTALLATION—These cylinders operate hydraulically, connected to a 500 p.s.i. pump and reservoir. Attached to derrick-type brackets, this assembly in turn is mounted on the gate valves. Piston rods of cylinders are connected to extension rods that go into valve gates.

Perhaps you too have a job that can be improved by Ledeen heavy duty cylinders.

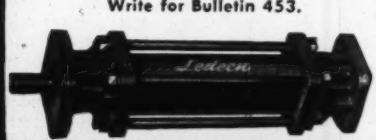
Wherever you have to...

PUSH OR PULL, LIFT OR LOWER, PRESS OR SQUEEZE, TILT OR TURN, OPEN OR CLOSE,

Ledeen heavy duty cylinders, operated by air, oil or water, will do it for you better and surer.

Standard Ledeen Cylinders with rod or head attachments are available from distributors' stock in major cities. Special cylinders on order.

Write for Bulletin 453.



LEDEEN CYLINDERS ARE GOOD CYLINDERS • LEDEEN CYLINDERS ARE GOOD CYLINDERS • LEDEEN CYLINDERS ARE GOOD CYLINDERS

Ledeen Mfg. Co.
DIV OF ENGINEERING PRODUCTS CO
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tributes to greater uniformity in succeeding reductions.

Another advantage obtained in tandem mills is that load indication on all rolls, readily enables distributing the reduction of stock among the rolls in such proportion that the load on rolls and driving motors can be more nearly equalized. The load cells also provide a visual check on bearing loads, which assures that they are not overloaded. This improvement alone is of considerable value in prolonging the life of a rolling mill.

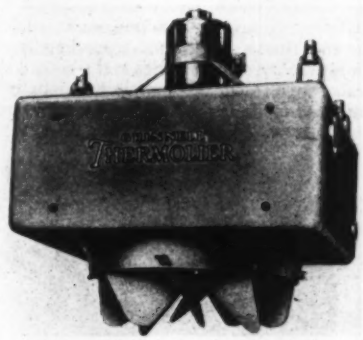
Set-up men on the illustrated mill found that this equipment increases mill output because they can thread the mill much faster. Threading is facilitated by the fact that properly centering the stock on the rolls equalizes the indicated loads on the ends of the rolls. Use of the load cells also makes it possible to adjust rolling loads, if necessary, while the mill is running. This improvement in control has appreciably reduced scrap on the tandem mill because the load indicators immediately tell the operator when sheet steel is being tapered and is not within gage specifications.

For experimental purposes, rolling mill load data can be used to show the effect of varying physical properties of rolling stock and to study rolling loads in relation to reductions of initial stock to the required gages. This data is also useful in selecting the right roll for a job or in designing rolls suitable for any job. Load measurements show how the material in the roll reacts to various forces.

SR-4 load cells are compensated for temperature variations and for changes in modulus of elasticity caused by temperature changes so that they give good reproducible accuracy over a range of plus or minus 50 deg. F. Accuracy of the indicator is high and permanent. An overall accuracy of 1% of full scale is guaranteed for load cells and instrument under normal mill conditions.

New Grinnell Thermolier

A new Grinnell Thermolier for vertical delivery of heated air from heights above the floor ranging from 9 to 25 feet is announced for delivery in the present heating season.

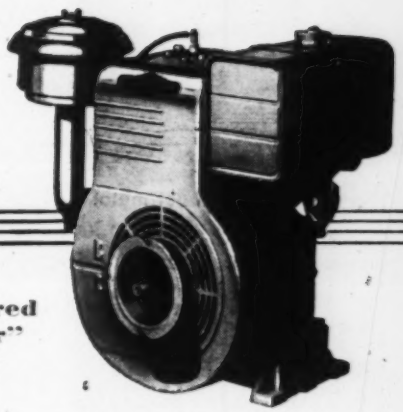


Six models are offered in the new line with heating capacities on the standard rated basis of 2 lb. steam and 60° entering air temperature, ranging from 50,800 Btu per hour to 257,000 Btu per hour. With higher steam pressures and other entering air temperatures these capacities are increased. The patented internal cooling leg and close connection of a thermostatic trap assures continuous drainage and full heating capacity under all conditions of use.

Three point suspension from adjustable swivel couplings simplifies suspension and alignment of the new vertical delivery units. Supply and return piping connections are on one side for compactness, neatness and economy. Permanent built in pitch for

Continued on Page 48

No other Engines in their field can match the record of Briggs & Stratton Engines



"America's Preferred Air-Cooled Power"

There are more Briggs & Stratton air-cooled gasoline engines in service — on farm equipment, industrial machines, tools, and appliances — than all other makes of gasoline engines in their field combined.

Briggs & Stratton is the world's largest builder of single-cylinder, 4-cycle air-cooled engines — with unmatched engineering and manufacturing experience gained in more than 30 consecutive years of continuous production and the building of more than 4 million air-cooled engines.

You can depend on Briggs & Stratton engines — "America's preferred air-cooled power".

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4 CYCLE BRIGGS & STRATTON GASOLINE ENGINES

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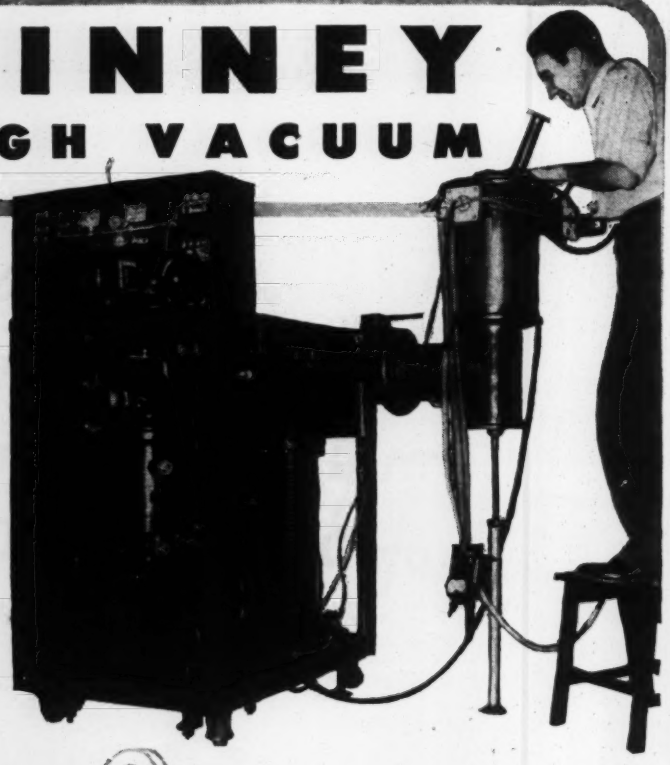
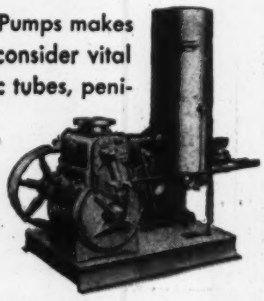


HELPS UNLOCK
NATURE'S VAST RESOURCES OF TITANIUM

Titanium — the wonder metal — is the 4th most abundant structural metal on earth. But for nearly 150 years titanium as a metal had been just another laboratory curiosity. The vacuum pilot plant shown in operation at Remington Arms Company, Inc., is now melting high quality titanium metal. Kinney High Vacuum Pumps are used in the operation.

Low pressure processing with Kinney High Vacuum Pumps makes available — at low cost — many of the things we consider vital to our American way of life — lamps and electronic tubes, penicillin, sintered metals, dehydrated food products, coated lenses, etc. Perhaps *your* product can be improved and its production cost reduced by use of Kinney High Vacuum Pumps. Ten models supply any range of vacuum down to low absolute pressures of 0.5 micron. Write for Bulletin V45.



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Making New Things Possible

KINNEY
HIGH VACUUM PUMPS

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each individual U-Tube assures continuous drainage and permanently bonded individual square fins assure uniform heat transfer.

Electric motors for the vertical delivery Thermoliers are built to specifications to handle the fans of special design. Wide spacing of the fins minimizes dirt collection. A housing of heavy gauge sheet steel covers the assembly and is typical of the rugged construction and advanced engineering in this new unit that completes the Grinnell Thermolier Unit Heater line.

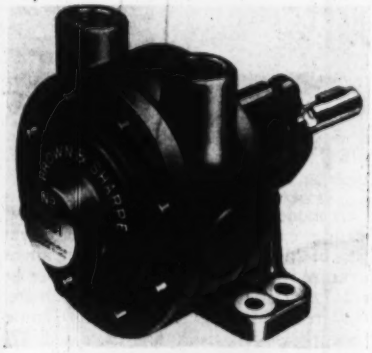
Additional information may be obtained by writing to Grinnell Co., Inc., 277 West Exchange St., Providence 1, R. I.

Hot Air Ducts

Although hot air ducts are a minor item in the manufacture of large steam generating units, they involve large amounts of material and require considerable floor space for the shop assembly required to insure proper fit in the field. This view shows half of a complete section assembled in the shops of Combustion Engineering—Superheater at Chattanooga, Tenn. Four complete sections or eight such units will be required for the two 670,000-lb C-E steam generating units now being installed in the Dunkirk Steam Electric Station of the Buffalo-Niagara Electric Corp. The total weight of the four sections will be 75,000 lb. When installed in the field, the "knocked-down" sections will be bolted together and then welded.

New Line of Brown & Sharpe Automatic Reversing Pumps

These pumps are an important addition to the Brown & Sharpe expanding line of pumps, offering nine styles and sizes of a new vane type, made as complete pumps or as stripped models, they possess many interesting features.



Nos. 8021, 8061 and 8101 are the complete pumps having provision for mounting the foot at top or bottom or on either side.

Designed for continuous operation against pressures up to 100 lbs., the capacities in G.P.M. at 0 lbs. pressure are, for the No. 8021 from .6 to 2.5; No. 8061 from 1.4 to 5.4 and No. 8101 from 2.9 to 11.5.

Similar capacities are available in stripped models with housings and stripped models

Silicone News

DC SILICONES

Here's How DC Silicone Insulation Reduces Motor Failure

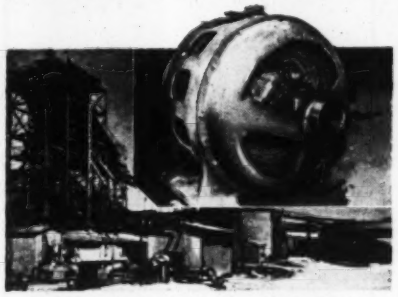


Photo courtesy Virginia-Carolina Chemical Corp.

THIS 300-H.P. silicone insulated motor was back in service three hours after being flooded with water, mud and waste.

• Engineers of Virginia-Carolina Chemical Corporation agree that DC Silicone Insulation is the best solution to motor failure caused by excessive moisture. They proved this in two identical 300-h.p. motors, one wound with Silicone (Class H) and the other with Class B insulating materials.

Located side by side and exposed to the same operating conditions, these motors are used to pump waste materials at the Phosphate Mine in Homeland, Florida. After the main line broke last year and flooded both motors with water, mud and waste, the Class B motor had to be reworked and rebaked. The motor wound with Class H insulation was simply cleaned with an air hose and the bearings were flushed out . . . ***Three hours later, the SILICONE INSULATED motor was back in service and operating perfectly.***

That confirms again the fact established by 4 years of motor testing: Class H Insulation made with Dow Corning Silicones has at least 10 times the life and 10 times the wet insulation resistance of the best insulating materials previously available. For more information on how silicone insulated equipment can save you time and money, phone our nearest branch office or write for booklet X-12.

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FIRST in Silicones

Dow Corning

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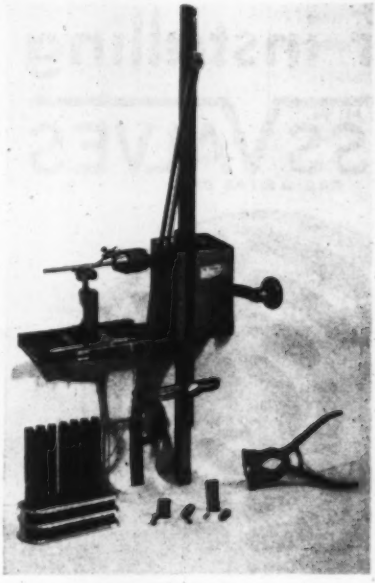
without housings. These designs meet the constantly growing demand of original equipment manufacturers for built-in or integral pumps. Designers with a view to streamlined appearances and economies will recognize their many advantages, particularly where power source is reversing. Outstanding examples of such applications are diesel engines, compressors, blowers, machine tools, speed reduction units, etc.

Semi-Automatic Spring-Coiling Machine

A semi-automatic machine for winding both left-hand and right-hand compression, extension and torsion springs is being marketed by The Carlson Co., 277 Broadway, New York 7, N. Y. The machine is especially useful for coiling small quantities of springs (up to about 100), and for making samples. The set-up time is only a few minutes and an operator can usually complete between 25 to 35 small-lot orders per day. Springs may be wound from spring steel, music wire, stainless steel, phosphor bronze or any other spring material.



It comes equipped with an arbor rack, containing 29 arbors made from ground, polished and hardened drill rods in sizes from $^1/_{16}$ inch to $^1/_2$ inch diameters advancing by 64ths. Three coiling points made from hardened tool steel, an extra wire holder for heavy wire and a wire cutter are also included.

The Carlson Spring-Coiler No. 1 will handle wire diameters up to 0.063 inch, and will coil springs up to $^3/_4$ inch diameter; however, larger outside diameters are obtainable with special arbors. Springs up to 4 inches in over-all length and up to 25 coils can be produced; pitches are adjustable from zero up to a wide range. The end coils of compression springs are closed or squared automatically, and the springs are wound with a uniform pitch and to an exact length. Extended lengths for forming special ends or hooks can be made. The machine is hand-operated but a motorized unit can be added if desired.

The machine is precision made. Material is best quality cold rolled steel for baseplates, gear box, and supports. Hardened tool-steel guides are used for slides and coiling points. All shafts revolve in bronze bushings. The

Continued on Page 50

AP-1 PANORAMIC SONIC ANALYZER

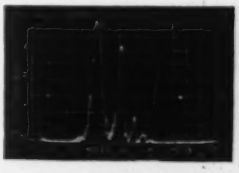
NOW! High-Speed VISUAL ANALYSIS

OF MECHANICAL NOISES OR VIBRATION

JUST ONE SECOND

. . . that is all it takes to automatically and visually portray frequency and relative amplitude of noise and vibrational components between 40 and 20,000 cycles. Model AP-1 is to the mechanical field what the X-Ray is to the medical world. It eliminates tedious, complicated point-by-point frequency checks and enables observation of changes in energy distribution, providing a quick overall view of the audio spectrum.

It is excellent for examining vibrations of rotating equipment which tends to hunt in speed and has proven highly successful in noise and vibration analysis of bearings, gears, electric motors, blowers, turbines, reciprocating engines, jet engines, and factory machinery. Simple to operate, it allows discrimination between vibrational components associated with rotational speed and others independent of speed. Investigate the overall advantages of AP-1 and discover it's efficiency in the mechanical field.



Panoramic Sonic Analysis showing frequency and relative magnitude of vibrational compooents produced by an eccentricity of a rotating member at approximately 3000 RPM.

These instruments are backed up by over 15 years' experience in developing and pioneering panoramic spectrum analyzers.

WRITE FOR FURTHER INFORMATION.

PANORAMIC RADIO PRODUCTS INC.

machine is enameled in a machinery gray finish. Each machine is assembled, inspected and tested before shipment. Sizes are as follows: baseplate, 4 x 15 inches; height of gear box, 5⅝ inches; length of long cam, 29 inches; and net weight (approximately), 25 pounds.

Mechanical Shaft Seals

For installation on equipment, moving or transferring liquids, which requires a positive shaft seal, as well as for replacement of conventional stuffing boxes where packing has proved unsatisfactory, Peerless Pump Division of the Food Machinery & Chemical Corp. has developed a new mechanical shaft seal to provide as perfect a mechanical means for prevention of leaks around a rotating shaft as is possible.

These seals are available in three general classifications—standard, abrasive-resistant and special. As the classifications imply, the standard shaft seal is suited for use when a limited amount of abrasive material is present in the liquid being pumped or transferred. The abrasive-resistant seal can be applied to all abrasive liquid conditions. The special is constructed of special materials to meet unusual liquid or fluid conditions.

The complete mechanical shaft seal is of Peerless' own design and manufacture and is of the cartridge type. Unit construction makes for easy replacement and maintenance. All liquids can be sealed; the type of seal to be applied depends on the abrasive qualities of the liquid, the corrosion problems encountered and the relative lubricating qualities of the liquid to be handled. Liquids such as water, gasoline, alcohol, hydraulic fluids, ammonia, brines, as well as concentrated or boiling acids and salts can be successfully sealed.

The maximum pressure recommended for these seals is 400 psi. Higher pressures require a special balance check. Liquid temperature handled can be up to 250 F with no water cooling; with water cooled stuffing boxes, liquid temperatures up to 300 F can be handled. Seals can be furnished for application to all rotating shafts ½" to 3" in diameter.

Further detailed information may be obtained by writing the manufacturer, Peerless Pump Division, Food Machinery & Chemical Corporation, 301 West Avenue 26, Los Angeles 31, California and requesting Bulletin B-571.

Photographs or electros to your specifications of any material in above-mentioned Bulletin are available upon request.

Flatness Accuracy to 11.6 Millionths Inch

Precision-measuring Lapmaster Optical Flats and Monochromatic Lights for checking flatness accuracy to less than one light band (.0000116") are now being marketed by the Crane Packing Co. of Chicago. The Monochromatic Light of this design was originally developed to check the extreme accuracy of parts lapped on the Crane Packing Company's Lapmaster machines, and it is equally effective for checking light band flatness of any superfinished surface.

The Lapmaster Monochromatic Light provides better than 25-foot candle power illumination on the checking surface. Its helium gas filled tubular light is recessed into the cover and diffuses light through a flashed opal diffusing glass. Light transmitted is a strong, near one-color light of 11.6 millionths of an inch per dark interference band.

Light source and checking stage are a self-contained unit, in a sturdy aluminum case. The unit is easily moved by means of an attached handle, and is adjustable from the stage type to a bench type by rotating the head 180°.

Lapmaster Optical Flats are of top quality natural quartz. They are highly transpar-

Advantages of VOSS COMPRESSOR VALVES

LARGER GAS PASSAGE AREA
1 From 20% to 100% increased valve area handles more and colder gas; a colder therefore denser gas costs less to compress.

LARGER VALVE AREA
2 Raises back and lowers head pressure, consequently reduces compression ratio—saving more power.

ELIMINATES SHUT DOWNS
3 Correct design—best materials—careful workmanship—means continuous performance.

SAFE
4 No castings used—therefore no invisible blow-holes or cracks which insures safety of operation. Gas passages drilled, slotted and milled smooth—hence less friction.

LONG LIFE
5 Made to the highest standard of workmanship—on special machines—by craftsmen—in a modern and well equipped shop—designed to give long life under the severest conditions.

NOISELESS
6 Smooth running—with less power—at higher speeds—without overheating.

ECONOMICAL
7 Increased capacity at a definite saving in power—replaces your present valves without any change in your compressor.

DEFINITE SAVINGS after installing J. H. H. VOSS VALVES
REG. U.S. PAT. OFF.

in your compressors

VOSS VALVES are indispensible for use where loads are heaviest; where lower operating costs are important; where safety and reliability are paramount. Increased speed after change over to VOSS VALVES often makes it possible to carry load with one compressor instead of two needed before.

Quotations and estimates on VOSS VALVES furnished on request. Case histories and testimonials of installations similar to your own supplied. Send us the name, bore, stroke and speed of your air, ammonia, or gas compressor of any type or size.

J. H. H. VOSS CO., Inc. 785 East 144th Street NEW YORK 54, N. Y.

• Keep Informed

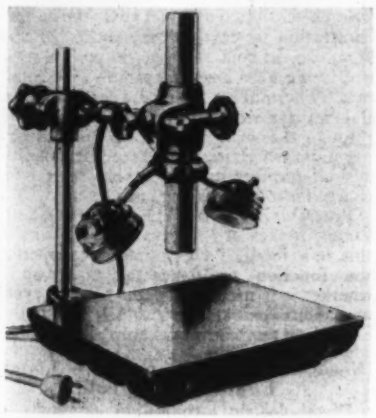
ent, have exceptional wear characteristics, are abrasion resistant and will withstand thermal shock. Flats of 1/10 light band, accuracy (.00000116") and 1/3 light band accuracy (.00000232") are standard with the Crane Packing Co. Sizes range to 6" diameters.

Full information concerning the Lapmaster Monochromatic Light and Optical Flats may be obtained from the Crane Packing Co., 1814 Cuyler Avenue, Chicago, Ill. A fully illustrated bulletin describing this equipment and the Lapmaster line of Lapping machines is available.

SKF Employee Education Course Begins

It's "back to school" for these three SKF Industries, Inc. employees as the ball and roller bearing firm, in a unique industrial relations experiment, makes after-hours education courses available to workers in its Philadelphia plants. Looking over a list of courses ranging from shop mathematics to quality control are June Schroyer (left), James Rodgers and Kenneth Shoemaker. More than 200 employees—seven per cent of the work force—are voluntarily enrolled in eight classes.

New Inspection Unit Features Sixteen Power Microscope



An illuminated layout plate with 16× microscope has recently been added to the line of the All American Tool & Mfg. Co., 1014 W. Fullerton, Chicago 14, Ill. Originally developed for surface inspection of finished carbide tools and inserts, as well as

Continued on Page 52

BW

you can put a **Bruning Whiteprinter** anywhere!

The modern design of a Bruning Whiteprinter makes it a self-contained unit. All it needs is an electric connection . . . and you are ready to produce sharp, crisp, black-on-white prints from your tracings . . . or anything typed, printed, or written or drawn in pencil or ink. Bruning Whiteprinters operate quietly. They require no plumbing connections and no ventilation ducts. Therefore they can be placed almost *anywhere* in your plant or office . . . at great saving on installation costs.

Add to this the savings of time and convenience—and the fast, uniform production of Bruning Whiteprinters. Then you can see why more and more firms are turning to BW, for better prints at lower costs.

There is a Bruning Whiteprinter model for every volume of work.

Send today for literature describing how you, too, can profit by using BW Copies. See for yourself why the BW System is the answer to your own copying needs. No obligation.

BRUNING WHITEPRINTER VOLUMATIC MODEL 93

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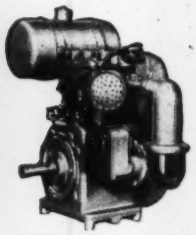
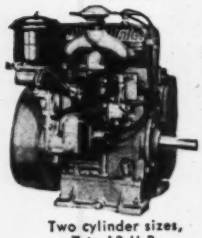
WISCONSIN
Heavy-Duty *Air-Cooled* Engines
Offer Reputability
TO MATCH YOUR OWN . . .



Single cylinder sizes 3 to 6 H.P.



Two cylinder sizes, 7 to 13 H.P.

V-type 4-cylinder sizes, 15 to 30 H.P.

If your company manufactures power-operated equipment of any kind that can utilize engine power within a 2 to 30 Horsepower range . . . your good name is safe when the performance of your equipment is entrusted to Wisconsin Air-Cooled Engines.

Here is reputability to match your own, no matter how high or exacting your standards may be. Every Wisconsin Engine from the smallest to the largest is of heavy-duty design and construction. The perfectly balanced drop-forged crankshaft of every Wisconsin Engine runs on tapered roller bearings at *both* ends to take up end- and radial thrusts . . . a typical detail of Wisconsin heavy-duty design that assures the user "Most H.P. Hours" of on-the-job service.

Wisconsin Heavy-Duty Air-Cooled Engines are available in 4 cycle single cylinder, 2- and 4- cylinder types in a complete power range up to 30 H.P.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 14, WISCONSIN

All These Were Once
DUST COLLECTION PROBLEMS, TOO

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208 Metallurgical Installations
205 Acid Plants • 40 Paper Mills
270 Detarring Installations
216 Power Stations
73 Steel Plants • 99 Oil Refineries
and Miscellaneous Installations

Your electrical precipitator installation will be individually engineered...and based on the Research Corporation's *experience* graphically shown by that towering pile of thousands of blue prints.

This knowledge is a valuable asset that will help Research engineers to "tailor-make" your Cottrell installation. For example, they can more quickly determine the right answers to such variables as the size, shape and type of both discharge and collecting electrodes, their relative spacing, flue arrangements and many other factors. At Research you can count on *profitable solutions to individual problems.*

Research Corporation Cottrells can be made as efficient as you desire. They can collect 95% to over 99% of all solid or liquid particles suspended in gas entering equipment. Write for free booklet giving valuable data. RC-121

Typical One Day Collections

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• 5500 POUNDS OF CONCENTRATED SULPHURIC ACID
• 6 TONS OF SODA SALTS AT PAPER MILL

RESEARCH CORPORATION

405 Lexington Ave., N. Y. 17, N. Y. 122 S. Michigan Ave. Chicago 3, Ill.

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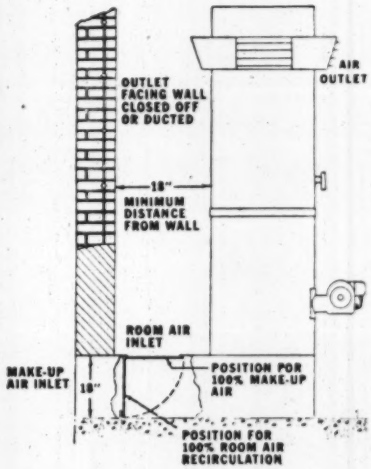
inspection of screw machine parts, these units are finding widespread application by tool and die makers, laboratory technicians and metallurgists One unit is in use by a bank to detect bogus money and others are in use by a textile mill, watchmaking firm and a lithographer.

Parts to be minutely examined or inspected are placed on the ribbed cast iron layout plate which is precision ground to .0005″ of true flatness. The microscope can be adjusted vertically and horizontally. A hand knob operates sensitive rack and pinion for focusing microscope.

Two lamps mounted on flexible tubing can be spotted on work being inspected. Microscope is 1¼″ dia., 9½″ long. Eyepiece and objective are achromatic lenses, blue (magnesium fluoride) coated. Unit plugs into 110 volt, a.c. outlet; 6 ft. rubber covered cord and plug are furnished. Literature sent on request.

Unit for Tempering Make-Up Air

A new model "Thermobloc" self contained, direct fired industrial heating unit has been announced by the manufacturer as well suited for the Tempering of Make-up air in buildings where a ventilating system imposes heavy loads on the heating plant in cold weather.



When ventilators are at work, the manufacturer points out, air to make-up for the volume ventilated off must enter the building. Infiltration by crack, doors and other openings, can, in cold weather, impose a serious overload on the heating system. To combat this, "Thermobloc" units are positioned along the walls, with air intake duct running through the wall. This feeds outside air to the units where its temperature is raised the desired number of degrees before it is discharged into the working area.

Prat-Daniel Corp., East Port Chester, Conn., maker of "Thermobloc," points out this new model "Thermobloc" can perform the function of tempering make-up air whether it is used as a plant heating system or as an auxiliary unit. Ask for bulletin SA-401 on tempering make-up air.

Diesel Locomotives now 'Live' Longer. Engineers Are Told

Diesel-electric locomotives not only are rapidly replacing the steam-driven engine, but mechanical science is making certain that they will be around for a long time.

This fact was disclosed here by F. S. Ball, SKF Industries, Inc., railway equipment engineer, who told the annual meeting of the Locomotive Maintenance Officers Association in Chicago September 21, that the normal

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life span of the big iron horses has been substantially lengthened in the last few years.

"One of the most spectacular improvements in diesel-electric locomotive equipment is the increase in endurance of all of its parts," he said. "Designers have succeeded in extending the lives of renewable parts either through more economic design or through the use of improved materials."

Ball said it had become necessary to double the life-expectancy of such important traction motor parts as anti-friction bearings to keep pace with new operating conditions. Bearings have now been developed to the point where the average minimum life is 1,500,000 miles.

"In the earlier days of the diesel-electric locomotive, shop inspections and servicing were frequent," he explained. "Now it appears that shopping intervals may reach as much as 500,000 miles or three to four years normal service."

Visual Analysis of Mechanical Noises and Vibration

Backed by over 15 years of continuous progress in panoramic techniques for analysis of radio frequencies, an entirely new system of audio frequency analysis, involving panoramic reception, has been announced by the Panoramic Radio Corp., 10 South 2nd Ave., Mount Vernon, N. Y. The system is now available for use by means of an instrument called the "Panoramic Sonic Analyzer," Model AP-1, which gives high speed, Visual Analysis of Mechanical Noises or Vibration.

Model AP-1 assures faster, simpler and more complete sonic analysis by automatically separating the frequency components constituting a complex audio wave and simultaneously measuring their frequency and amplitude. Moreover, the AP-1 opens up entirely new possibilities for solving various audio problems such as noises and vibrations. Designed for use in research laboratories, universities, mechanical engineering laboratories, recording studios, broadcast stations, sound film studios and in any other field requiring high speed audio measurements, the instrument is ideal for analyzing harmonics, vibration, noise and other sonic phenomena.

In its application to radio frequency studies, panoramic analysis had become with time, more and more familiar in research and engineering fields. Essentially, panoramic instruments are either mechanically or electronically tuned receivers in which the output is applied to a cathode-ray tube oscilloscope. As the panoramic sweeps through a series of signals in a band, it causes a corresponding series of pips—inverted Vs—to appear on the 'scope screen. By synchronizing the tuning

Continued on Page 54

THE Aldrich Central Hydraulic System illustrated above is installed in a textile belting plant, where it provides hydraulic pressure used in impregnating fabric belts with rubber and in laminating belt sections to produce continuous belting.

By means of the Aldrich-Groff "POWR-SAVR" Controllable Capacity Pump, all of the hydraulic pressure required—*but only that pressure actually needed*—is supplied. This pump automatically controls delivery—in almost direct proportion to demand.

And, by means of the Central System, all hydraulic pressure originates from a single, compact source—affording the least amount of machinery, less maintenance, and quick, easy accessibility. The Aldrich Central Hydraulic System is good engineering—simple, direct, efficient.

For whatever application of hydraulic pressure you may have, and to provide you with pumping equipment that specifically fits your individual requirements—Aldrich builds many types of reciprocating pumps, from the variable stroke "POWR-SAVR" through the constant stroke, constant speed, Inverted Triplex pumps—up to and including the Inverted Nonuplex of 2400 H.P.

For information or for assistance on any pumping problem, write to The Aldrich Pump Company.

Representatives: Birmingham • Bolivar, N. Y. • Boston • Chicago • Cincinnati Cleveland • Denver • Detroit • Duluth • Houston • Jacksonville • Los Angeles New York • Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. St. Louis • San Francisco • Seattle • Spokane, Wash. • Syracuse • Tulsa

THE ALDRICH PUMP COMPANY

29 PINE STREET, ALLENTOWN, PENNSYLVANIA

The **FIRST** *Name in Reciprocating Pumps*

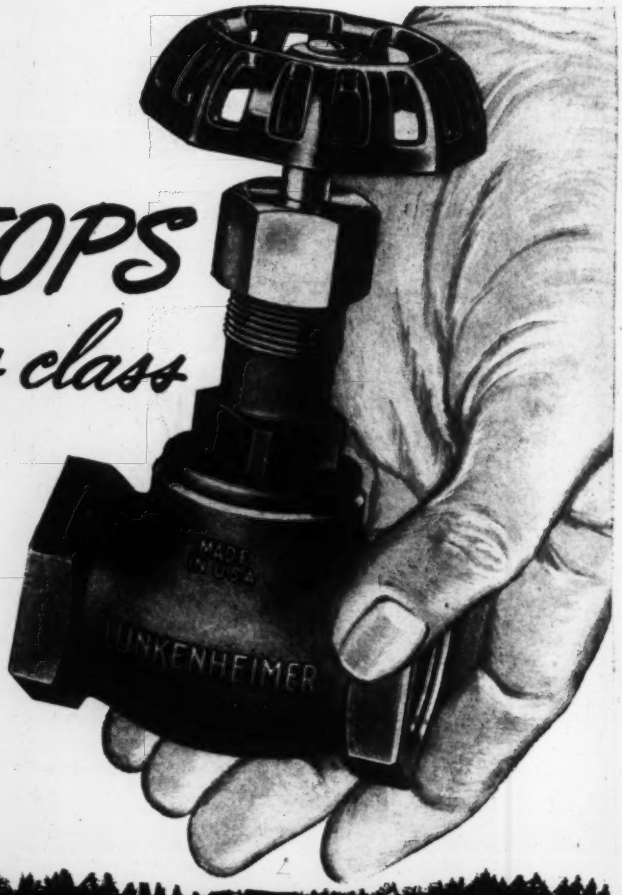

Fig. 2140
GLOBE
125 lb. S.P.
200 lb. W.O.G.

125 lb. S. P. BRONZE GLOBE, ANGLE and CHECK VALVES
Built to **LUNKENHEIMER**
QUALITY STANDARDS

Want a lower pressure valve to give the same dependable, low-cost service you get in higher pressure LUNKENHEIMER Valves?

Here it is — New Fig. 2140 Globe; Fig. 2141 Angle; Fig. 2142 Lift Check; Fig. 2144 Swing Check. These valves feature Lunkenheimer's traditionally fine design and sturdy construction, plus exclusive silicon bronze alloy stems which eliminate stem thread failure due to wear.

Whatever your requirements for lower pressure service, you'll find these new valves unequalled for dependability and true economy.

Your LUNKENHEIMER DISTRIBUTOR is stocking these new 125 lb. S.P. Bronze Valves. Call upon him for your original equipment, replacement and repair valve requirements. Ask him for Circular No. 582 or write direct.

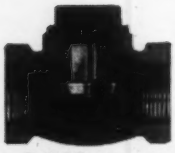

Fig. 2142 LIFT CHECK
125 lb. S.P. 200 lb. W.O.G.

Nowhere in the line is dependability more important than in Check Valves. These Checks function quickly and positively, seat accurately and tightly.

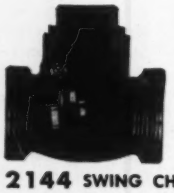

Fig. 2144 SWING CHECK
125 lb. S.P. 200 lb. W.O.G.

ESTABLISHED 1862
THE LUNKENHEIMER CO.
—"QUALITY"—
CINCINNATI 14, OHIO. U. S. A.
NEW YORK 13 CHICAGO 6
BOSTON 10 PHILADELPHIA 34
EXPORT DEPT. 318-322 HUDSON ST. NEW YORK 13, N. Y.

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with the horizontal sweep of the 'scope, the horizontal location of each pip becomes an indication of the frequency of its associated signal. The behavior of the pip helps identify the characteristics of the signal. Thus, with a single panoramic receiver it is possible to observe and to study either many signals at one time or a single highly complex radio frequency wave.

Audio and mechanical engineers and researchers have long recognized the many advantages of applying panoramic analysis in their fields and have persistently requested special panoramic equipments for the sonic spectrum. The "Panoramic Sonic Analyzer" has been designed to provide the answer to their requests for an instrument for examining vibrations of rotating equipment which tends to hunt in speed and has proven successful in noise and vibration analysis of bearings, gears, electric motors, blowers, turbines, reciprocating engines, jet engines and machinery.

With the AP-1 audio components are displayed spectrographically in two dimensions on a cathode-ray tube screen. By electronic means the instrument tunes repetitively, once per second, through a frequency range extending from 40 to 20,000 cps. As a component is tuned through, it appears on the c-r tube screen as a pip, the horizontal location of which is dependent upon the component frequency. The height of the pip, on the other hand, provides a direct measure of either the relative or absolute magnitude of the component. The screen is of the long persistence variety so that the indications remain on the screen during the entire one second scanning period. Thus an apparent simultaneous display of a series of pips is obtained for those frequencies which may be present in the spectrum.

The unique features of automatic measurement and spectrographic indications . . . eliminate complicated point-by-point frequency checks . . . enable observations of changes in waveform content either while the waveform itself varies in a random manner or while design constants are altered. Such observations heretofore have been extremely difficult or have been virtually impossible with slower point-by-point measurement methods . . . remove the chances of skipping by weak components . . . provide a quick overall view of the audio spectrum . . . allow measurement of individual intermodulation envelope components rather than just total distortion.

Simplicity of operation—a maximum of only three controls are used for most audio measurements—allows use of the instrument on production lines as well as in the laboratory. High inherent stability obtained through careful and ingenious design engineering assures minimum balance adjustments during normal operation. A simple self-contained voltage and frequency calibrator enables quick easy checks of calibration accuracy.

The AP-1 is direct reading. A special light filter over the viewing end of the c-r indicator is calibrated logarithmically from 40–20,000 cps along its horizontal axis. The vertical axis, calibrated for component amplitude measurements, has a linear scale with a 10:1 range and a long scale of 40db. A front panel selector switch extends the overall range to 1000:1, or 60db. Extreme versatility of application is made possible by a wide input voltage range—500 microvolts to 500 volts for full scale indications—and a constant high input impedance of 250,000 ohms. Fourier analyses of square, rectangular, triangular and sawtooth waves can be made for either research or demonstration purposes. For investigation of noises and

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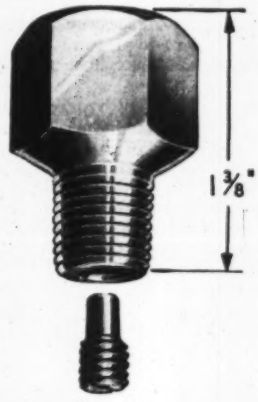
high frequency vibrations a highly useful distribution pattern of energy versus frequency is provided.

The "Panoramic Sonic Analyzer" consists of a sonic analyzer chassis plus a power supply chassis. Both chassis are mounted in a well-vented sturdy steel cabinet finished in grey wrinkle. The unit operates from a 115V/230V 50–60 cycle source; power consumption is 100 watts. Send for latest bulletin.

New Stainless Steel Cartridge Snubber



Helicoid Gage Div. of the American Chain & Cable Co., Inc., has just announced a new stainless steel cartridge snubber.

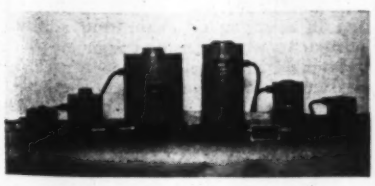
Made with a cartridge of compressed powdered stainless steel and a steel body, it is a simple and effective throttling device for pressure gages to reduce or eliminate pulsations of the gage pointer. No adjustments are needed. Specific porosity of cartridge makes it effective for required service—air gas, water, steam or oil. Available for all pressures up to 10,000 pounds.

Since this cartridge contains thousands of minute particles of stainless steel, the chances for clogging are considerably less than for the conventional snubber with a single, very small hole.

Cartridges may be easily removed and cleaned, if necessary, or may be replaced.

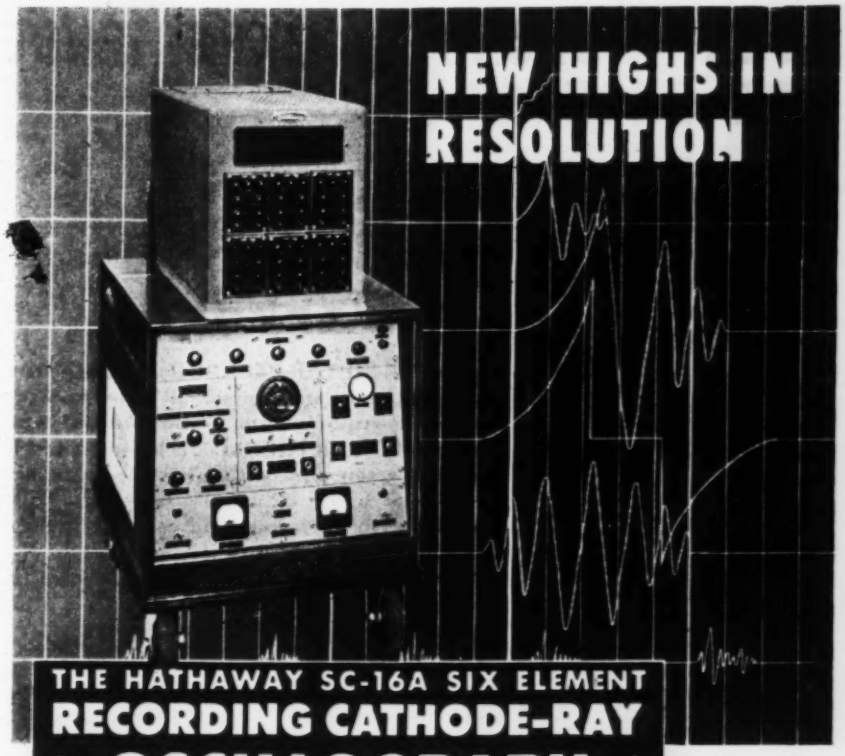
New SR-4 Load and Pressure Cells

Five new SR-4 type load and pressure cells, extending the range of standard models on both high and low sides, are announced by The Baldwin Locomotive Works, Testing Equipment Department, Philadelphia 42, Pa. The sensitive elements of these cells are SR-4 resistance wire strain gages. In the load cells, SR-4 gages are bonded to a compression column, loads being indicated or recorded manually or self indicating type instruments.



Two new compression type load weighing cells of 100,000 and 200,000 lb. capacity make a total of seven standard Type C cells starting at 2000 lb. capacity. Special cells of this type up to 1,500,000 lb. capacity have been built to order.

Continued on Page 56



THE HATHAWAY SC-16A SIX ELEMENT
RECORDING CATHODE-RAY
OSCILLOGRAPH

NEW HIGHS IN RESOLUTION are obtained by this new oscillograph because of its unusually HIGH FREQUENCY RESPONSE and HIGH CHART SPEED...designed for recording fast transients and continuous phenomena.

FREQUENCY RESPONSE 0 to 200,000 cycles per second
RECORDS up to 1000 ft. long at speeds up to 600 inches per second
RECORDS up to 10 ft. long as speeds up to 6000 inches per second
WRITING SPEED above 100,000 inches per second

Note these additional unusual features.

- **SIX ELEMENTS** with convenient interchangeable lens stages for 1, 2, 3, or 6 traces on full width of chart.
- **INTERCHANGEABLE RECORD MAGAZINES** for CONTINUOUS RECORDING on strip chart, either 6 inches or 35mm in width up to 1000 feet in length, DRUM RECORDING for short, high-speed records, and STATIONARY CHART for very short transients.
- **PRECISION TIMING EQUIPMENT**, tuning fork controlled, for 1-millisecond or 10-millisecond time lines.
- Crystal-controlled **Z-AXIS MODULATION** for 1/10 millisecond time marks.
- **QUICK-CHANGE TRANSMISSION** for instantaneous selection of 16 record speeds over a range of 120 to 1.
- **AUTOMATIC INTENSITY CONTROL.**
- **CONTINUOUS SWEEP OSCILLATOR** which permits viewing as well as recording.
- Single-pulse **LINEAR OSCILLATOR** for recording transients on stationary film. The record can initiate the transient to be recorded, or the transient can initiate the record.

Each recording element is a complete unit, fully housed, which can be instantly inserted or removed. Recording element contains high-intensity cathode-ray tube, and both AC and DC amplifiers. Control panel is located on outside end.

FOR FURTHER INFORMATION, WRITE FOR BULLETIN 2 G 1K

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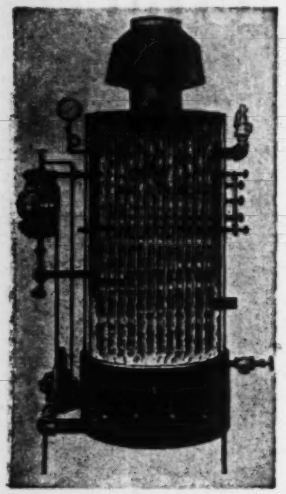
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

OVER 4 DECADES' EXPERIENCE ARE BACK OF . . .



The KANE Boiler is built to A.S.M.E. specifications, in sizes to 30 H.P.

the Kane Boiler Package

Each KANE BOILER PACKAGE is carefully considered by us as an "individual" job—from the customer's requirements to the finished unit. And each BOILER PACKAGE is a compact, self-contained steam source that includes: the correctly sized KANE Automatic Gas-Fired Boiler complete with gas burner and controls to maintain required steam pressure; and an M-K-O Automatic Boiler Feed system designed to return condensate and supply make-up water as required for highest operating efficiency.

Engineered Steam at its best, with over 40 years' experience at your disposal—so, send your steam problems to us for study and recommendation.

ENGINEERED STEAM AT ITS BEST

MEARS·KANE·OFELDT INC.

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FOUR DECADES OF AUTOMATIC GAS-FIRED BOILER MANUFACTURING EXPERIENCE

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ROTARY MECHANICAL SEALS and PACKING TOOLS

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The size range of the recently developed universal load cells for both compression and tension loads has been extended upward from 50,000 lb. to 100,000 lb., making a total of six standard cells ranging down to 500 lb. capacity.

Supplementing the SR-4 load cells are SR-4 load beams with which it is possible to obtain load measurements down to 2 grams, full scale. Cantilever beams with capacities as high as 1000 lb. have been built.

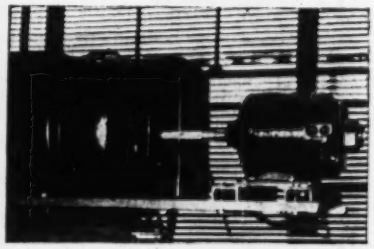
Eleven sizes of SR-4 fluid pressure cells are now available with the addition of a cell of 10 lb. per sq. in. capacity on the low end of the scale, and two cells of 100,000 and 150,000 lb. per sq. in. capacity on the high end. In these cells SR-4 gages are bonded to the outside surface of a pressure tube with an open end that may be connected into a pressure system.

Baldwin load cells of hydraulic and pneumatic types are available also. Emery hydraulic types range in capacity from 20,000 lb. to 100,000 lb. with special cells as low as 40 lb. capacity and as high as 5000 tons capacity. Standard air cells range from 6 lb. to 1000 lb. capacities with indicator ranges as low as 0 to 0.5 lb. full scale.

G. E. Announces New Heavy-Duty D-C Tachometer Generator

For accurate speed measurement of steel- and aluminum-mill machinery, mine hoists, crushing and shipboard equipments, wire-forming machines, paper-mill drives, etc., a completely redesigned heavy-duty d-c tachometer generator has been announced by General Electric's Special Products Division.

Available in three models, the new generator is totally enclosed and features rubber-mounted ball bearings and an alnico permanent-magnet field (no separate excitation is required). The end play has been preloaded to 100 lbs. to counteract the end thrust of the large machines to which this sturdy new unit is to be mounted.



Output voltage of the generator is directly proportional to speed. Sufficient power is produced for (1) control purposes and operation of an instrument simultaneously, or (2) operation of several instruments in parallel. The unit operates in either direction; clockwise and counterclockwise rotation can be indicated by a zero-center instrument.

A speed-volt curve is taken of each new generator and a copy is kept on file at the General Electric plant. This curve can be used in selecting or calibrating additional instruments without using the generator.

Having a cast steel base solidly welded to the frame, the new generator may be mounted either vertically or horizontally. It has a $^{5}/_{8}$- × $1^{7}/_{8}$-in. shaft with a keyway on the pulley end and a $^{1}/_{8}$-in. extension on the commutator end for hand tachometer readings. To permit belt adjustment, the base has been designed with slots measuring $^{11}/_{32}$-in. wide and $^{7}/_{8}$-in. long. Connection from generator to driving shaft can be direct or by means of gears, chain, belt, etc. Permissible end play is $^{1}/_{64}$ in.

Speed ranges for the three models of the new generator are 100–1450, 100–2500, and

• Keep Informed

100–5000 RPM. Accuracy is plus or minus 0.3 per cent of full scale with the DP-2 portable instrument, and plus or minus 1.0 per cent of full scale with other indicating instruments.

The machines are equipped with a cast iron waterproof conduit box with gaskets in conduit box assembly, and gaskets under the brushholder covers and leather shaft seals. Anti-chatter brushes are used and there is a breather plug in the bottom of the P. E. flange. The electric connection to the instrument, which may be remotely located up to several thousand feet from the generator, can be made either by conduit or by open wiring. The smallest size lead recommended is double conductor No. 16 AWG.

SKF to Supply 23 Tons of Bearings For French Mill

SKF Industries, Inc., recently announced receipt of an order for 23 tons of anti-friction bearings to be installed in a hot strip mill in the heart of France's Lorraine iron ore basin.

The order was placed by United Engineering & Foundry Co. of Pittsburgh, which will construct the mill for the Societe Lorraine de Laminage Continue (Sollac). It calls for 76 spherical roller bearings weighing a total of 45,756 pounds for the mill's drives and pinion stands.

The Philadelphia firm regularly supplies spherical roller bearings to most of the nation's steel and aluminum mills.

The bearings destined for France range in size from two to three feet in diameter and weigh from 459 to 1,342 pounds apiece. The largest bearing has a catalog load rating of 1,290,000 pounds at a speed of 33⅓ revolutions per minute.

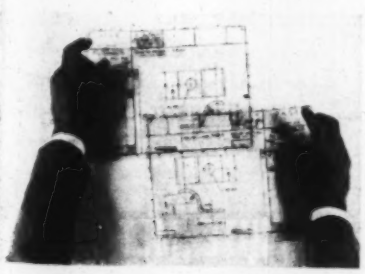
SKF engineers said the 55,250 horsepower required to operate the continuous mill and transmitted through the roller bearing-supported drives and pinion stands is sufficient to supply the electric power needs of a city of 75,000 population.

U.S.-built equipment for the French mill is being financed by the ECA.

New Autopositive Film Provides Maximum Print-Back Speeds In Reproducing Drawings, Maps

Rochester, N. Y.—A revolutionary, new direct-positive film for making top-quality reproductions of engineering and architectural drawings and of maps and physical surveys has been developed by the Eastman Kodak Co.

Known as Kodagraph Autopositive Film, the new film may be handled in normal room light and produces a positive copy directly from a positive original drawing, without a negative step. It may be exposed on blueprint or whiteprint equipment or other copying machines having a high-intensity light source.

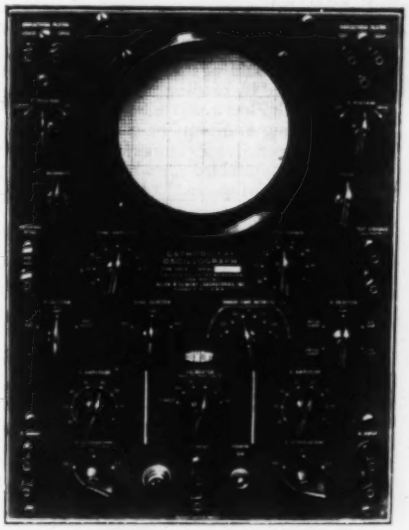


Similar in characteristics to Autopositive paper, the film provides maximum print-back speed because of its highly translucent support and easily retains fine lines and

Continued on Page 58

INDUSTRIAL ENDURANCE WITH RESEARCH *Quality*

DU MONT TYPES 250-AH and 250-A Cathode-ray Oscillographs



★ **For RESEARCH . . .**

. . . . where utility and precision work demand high-quality performance and steadfast dependability.

★ **For INDUSTRY . . .**

. . . . where a wide range of applications and adverse operating conditions demand general-purpose versatility and rugged endurance.

★ Cathode-ray Oscillography—rapidly becoming an indispensable aid to industry—instantaneously translates various phenomena into luminous-screen patterns for immediate study or for permanent record.

And Du Mont offers the most advanced oscillographs, such as the Types 250-AH, and 250-A with . . . .

These High-Voltage Features in the Type 250-AH:

Accelerating potentials up to 14,000 volts using the Du Mont Type 5RP-A High-Voltage Cathode-ray Tube, supplied by the Du Mont Type 263-B High-Voltage Power Supply.

Sufficient light output to photograph oscillograms with the Du Mont Type 271-A or 314-A Oscillograph-Record Cameras.

Projection of oscillograms with the Du Mont Type 2542 Projection Lens.

These versatile features in both the Type 250-AH and 250-A:

Three types of input connections, including d-c amplifiers, for observing slowly changing phenomena.

Completely flexible sweep circuit: sweep durations variable from 5 seconds to 10 microseconds with exceptional linearity over the entire range.

Built-in voltage calibrator for precise quantitative measurements.

Provision for intensity modulation of the cathode-ray beam for precise measurements of time.

15″ h., 11″ w., 19″ d. Weighs 68 lbs.

★ **Literature or demonstration on request, without obligation. Free subscription to the Du Mont Oscillographer.**

DUMONT *for Oscillography*

ALLEN B. DUMONT LABORATORIES, INC.,

INSTRUMENT DIVISION, 1000 MAIN AVENUE, CLIFTON, NEW JERSEY

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REQUIRE NO MAINTENANCE

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½ to 40,000 HP
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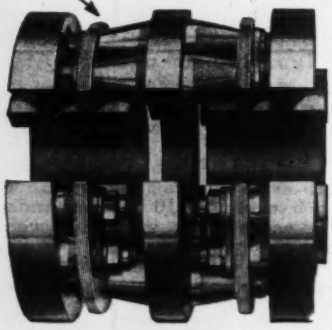

THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT.

NO MAINTENANCE PROBLEMS.

ALL PARTS ARE SOLIDLY BOLTED TOGETHER.

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WARREN, PENNSYLVANIA

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minute detail because of the high resolving power and contrast of the silver-sensitized emulsion. As a result, the film is unequalled for restoring worn, stained, or faded drawings without the necessity of retracing by hand. Its printing speed, three to five times faster than intermediates on paper, makes it particularly valuable for turning out large quantities of shop prints in the shortest possible time.

Since the base of Kodagraph Autopositive Film is highly translucent, it may be printed with the emulsion side of the film in contact with the face of the drawing to produce a "reverse-reading" positive which can be easily viewed from the back to become, in effect, right-reading.

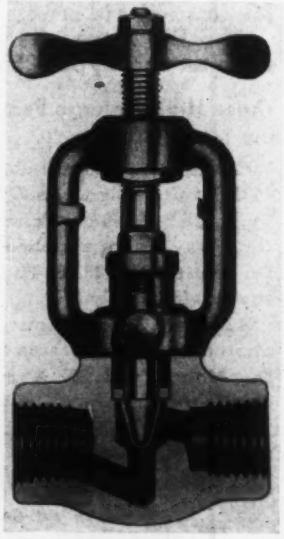
It also can be reflexed when copying material printed on opaque stock or on both sides of a page, and again a "right-reading" print is obtained by reading through the back.

The film has a matte surface on both sides, permitting additions or corrections in either ink or pencil. Erasures may be made by using a standard two-solution eradicator. Where drawings are to be revised, the Autopositive Film may be used as an overlay in combination with intermediates on either cloth or paper.

The film is available in both 30- and 100-foot rolls in the following widths: 24, 30, 36, 42, and 44 inches.

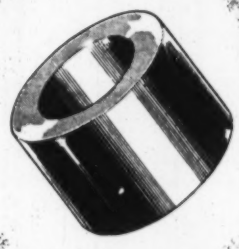
New Edward Forged Steel Instrument Valves Provide Close Regulation on Small Lines

East Chicago, Ind.—New forged steel instrument valves now being built by Edward Valves, Inc., East Chicago, Ind., fill a long felt need for an exceptionally strong steel valve small enough to install in a limited space. These valves are particularly useful to manufacturers of meters, gages, pumps, regulators, and other small control equipment which is accompanied by an instrument valve.



Constructed of carbon steel, 13 per cent chromium stainless steel, or 18-8 stainless steel, these new instrument valves are now available in globe or angle design in ¼ in., ⅜ in., and ½ in. sizes with screwed or socket welding ends. They have outside screw and yoke construction and the yoke is screwed onto the body and tack welded. The carbon steel valves are rated at 1500 lb 850 F and the 13 per cent chromium and 18-8 stainless steel designs are rated at 1500 lb

WORKS WHERE OTHERS WON'T



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SELF-LUBRICATING ● EXTREMELY DURABLE ● CONSTANT CO-EFFICIENT OF FRICTION ● OPERATES DRY — OR SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS ● APPLICABLE OVER A WIDE TEMPERATURE RANGE — even where oil solidifies or carbonizes ● EXCELLENT AS A CURRENT-CARRYING BEARING.

GRAPHITE METALLIZING CORPORATION
1058 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

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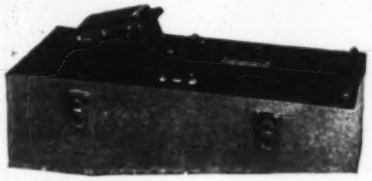
at 1000 F. WOG rating for all of these valves is 6000 lb at 100 F.

These new instrument valves are ideal for providing close regulation on orifice meters, regulator lines, gage lines, instrument panels, Christmas tree valve constructions in the oil fields, pumps, by-pass lines, and other small lines in central power stations and boiler houses of many types of industries. The valves built of stainless steel have the added advantage of resistance to many of the corrosive influences found around chemical processing and petroleum refining plants, and also are quite useful on steam sampling systems where it is important that the feed sample not be contaminated in any way.

Write for free Bulletin 491 on the new Edward Instrument valves.

General Electric Announces New Low-Priced Oscillograph

A new low-priced, lightweight oscillograph especially designed for use in schools, colleges, and industrial laboratories has been announced by General Electric's Meter and Instrument Divisions.



Compact and simple in design, the new Type PM-18 instrument can easily be operated by inexperienced personnel, in the laboratory or in the field. It can be used either for visual indications or for taking oscillograms of current and voltage phenomena.

While the standard model is equipped with two elements, it can be furnished with three or four if desired. The new oscillograph uses a new, improved type of galvanometer with bifilar suspension which produces high-flux density in the gap.

Priced at $575.00 (F.O.B. factory), two-element model furnished with a filmpack for processing one or more records before the complete set of negatives has been exposed.

This oscillograph can also be furnished with a special film holder which uses the Polaroid-Land film and produces finished oscillograms in less than one minute—without the use of a photographic darkroom.

G-E Motors Give 40 Years Service

After 40 years of heavy-duty service with Dolese & Shepard Co. quarry, LaGrange, Ill., 30 General Electric motors, ranging from five to 250 horsepower, are still operating efficiently, it was learned recently.

Installed in 1909 when the quarry first began operations, the motors have been used steadily with a minimum of repair and servicing, while undergoing severe quarry loads and working conditions.

W. J. Schwass, superintendent of the quarry, said, "Often, because of conditions, we couldn't give these motors the care a motor should have, but they stood up. Being open motors, they are exposed to all the dust of a quarry, but we've had very little trouble from electrical failure. Only on rare occasions have they needed repair work. Almost all of them still have their original windings—40 years hasn't fazed them.

Included among the 30 G-E motors are: one 250-hp motor which drives the main crusher, handling 600 tons of limestone an hour; five 100-hp motors which drive

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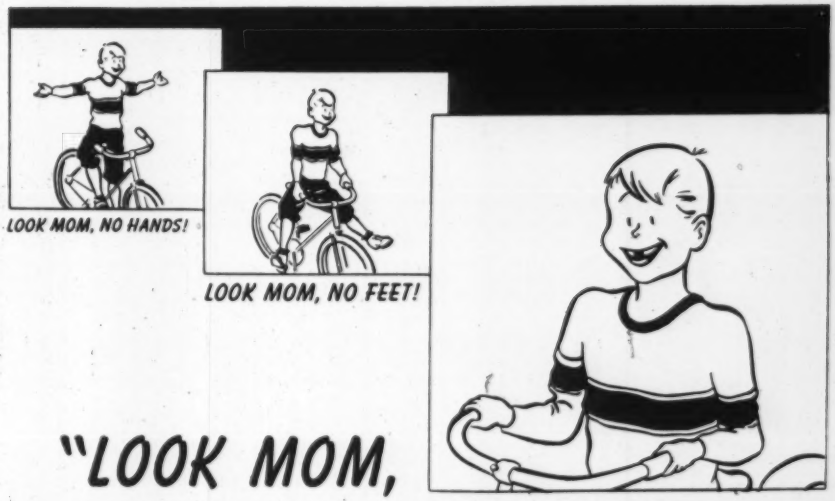


"LOOK MOM, NO TEETH!"

"... The gages specified on the above order are to replace standard clock gear movement type now in use to indicate pressures in several of our chemical processes which are subject to considerable pulsation. From previous experience the writer has found the Helicoid movement to be far superior to the old type."

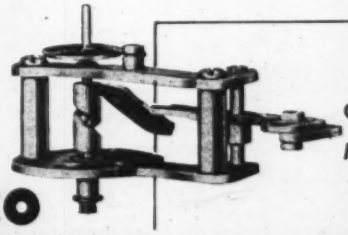
Signed by a Plant Superintendent.
Name of company on request.

●There's only one reason why a plant superintendent would consider HELICOID gages "superior" to others on a tough application.

They save money!

Of course they have to be dependably accurate—long-lasting—easy to calibrate. Those are the advantages that add up to lower cost per gage, per year. And the more gages you use, the more substantial the saving.

Send for your copy of the new HELICOID GAGE catalog now.



Only Helicoid Pressure Gages have the Helicoid Movement

ACCO

HELICOID GAGE DIVISION
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secondary crushers; six 50-hp motors doing such jobs as running half-inch revolving screens; two 5-hp motors for Niagara screens; and others doing routine quarry duties.

Maintenance engineers of the company reported that the only repairs needed on these motors were insulation and winding repairs; most of the motors have not required even that.

Dolese and Shepard have recently specified modern G-E motors for new applications or replacements in this quarry.

• LATEST CATALOGS

Expansion Joints

"CMH Expansion Joints", bulletin EJ-49, is a new illustrated bulletin in two colors just published by Chicago Metal Hose Corp., Maywood, Ill. This bulletin was prepared to give engineering and product information to operating and engineering personnel in industrial fields dealing with piping where pressure and temperature extremes exist, and where pipeline expansion under working condition is a prime consideration.

Information contained, covers both "Free-Flexing" and "Controlled-Flexing" corrugated type expansion joints in copper and and stainless steel construction. To the design and manufacture of the expansion joints described in this bulletin has been applied this Company's knowledge and skill acquired through 47 years' experience in the fabrication of ferrous, non-ferrous and alloy metals.

Copies of this bulletin will be furnished by C. M. H. to persons who have a direct interest in expansion joints and who indicate their company affiliation and title or function.

Bulletin on G-E Telemetering Systems Available

A 20-page, illustrated bulletin, GEA-5233, which describes the newest General Electric telemetering equipment for electric power distribution and industrial applications, has just been released by the company.

The bulletin gives detailed information on the frequency type, torque-balance-type, and photoelectric-type telemeters manufactured by G.E. Included also are simple wiring diagrams of typical telemetering installations for various services, and descriptions, dimensions, and specifications of telemeters and auxiliary equipment, such as torque-balance converters and torque-balance load injectors.

Facts About Pre-Lubricated Bearings

A new booklet, available from Westinghouse Electric Corp., presents facts about the pre-lubricated bearings used in Life-Line motors.

Starting with a discussion of why pre-lubricated bearings are possible, the booklet includes sections devoted to "Desirable Qualities of Grease," "Tests to Prove the Adequacy of Grease," and "Tests to Prove the Seal's Effectiveness." Several case-history-type examples are included.

For booklet (B-4378) write Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa.

Stock Sprocket Catalog

The enlarged line of various types of Stock Sprockets and of single and multiple-strand Diamond Roller Chains carried in stock by its nationwide distributor organization is described in the new 40-page Stock Sprocket Catalog No. 709 just published by the manufacturer, Diamond Chain Co., Inc., 413 Kentucky Ave., Indianapolis 7, Ind. Appropriate data for selection of Sprockets and Chains is given plus illustrations, dimensions, and prices. These catalogs are available through the main office, engineering offices, and distributors.

Centrifugal Blowers and Exhausters

Roots-Connersville Blower Corp., Connersville, Ind., has just issued a completely revised 24-page booklet in two colors covering its Centrifugal Blowers and Exhausters, Bulletin 120-B-14.

The foreword reviews Roots-Connersville's extensive experience in designing centrifugal units, and moves along into a discussion of the various centrifugal advantages. This is followed by a detailed discussion of the operating characteristics of R-C units.

Six pages are devoted to the design and construction features of single stage units, with illustrations of the various types, and equal space is given to a similar discussion and illustrations of the multi-stage units. Both sections are profusely illustrated, including cross-sections, diagrams, curves, exploded views, etc.

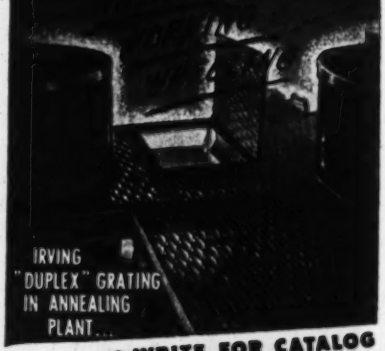
A two-page spread is used to cover the subject of regulation, accompanied by cuts showing approved regulating devices. This section is followed by three pages packed with cuts showing typical installations of both the single and multi-stage R-C centrifugals.

R-C "dual-ability" is discussed on the inside back cover, stressing the advantage of being able to offer both rotary positive and centrifugal units, which R-C claims as a unique distinction. Here also appears a list of sales offices in 20 major industrial areas. The back cover illustrates, and briefly de-

Do you know that every year thousands of plants are made SAFER MORE COMFORTABLE MORE EFFICIENT

IRVING GRATINGS

(OPEN STEEL MESH FLOORING)



IRVING "DUPLEX" GRATING IN ANNEALING PLANT...

• WRITE FOR CATALOG

IRVING SUBWAY GRATING CO., INC.
ESTABLISHED 1902
Home Office and Plant: 5010 27th Street
LONG ISLAND CITY 1, NEW YORK
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EMERYVILLE 8, CALIFORNIA

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scribes, other R-C products, including inert gas generators, positive displacement meters, and cycloidal vacuum pumps; briefly outlining many applications.

SR-4 Strain Gage

A new 12-page catalog of Baldwin SR-4 bonded resistance wire strain gages, illustrated by line drawings distinguishing 11 types of gages and listing 102 standard gages, is announced by the Testing Equipment Department, The Baldwin Locomotive Works, Philadelphia 42, Pa. These gages are classified by types of wire and cementing materials to be used. A single table gives electrical resistances, gage factors, dimensions and prices. The catalog also lists prices of all SR-4 equipment and accessories used with the gages. A list of "things to consider in the selection of SR-4 strain gages" with references to Baldwin bulletins in which further information can be obtained, is also included.

In general, the catalog shows extensive price reductions from last year, reflecting a growing confidence in these gages and methods of using them. The resultant growing demand for them permits the economies of a larger scale of production, which can be passed on to users in spite of higher costs of materials and labor.

Price Sheets for Seamless Carbon Steel Merchant Boiler Tubes

Beaver Falls, Pa.—The Babcock & Wilcox Tube Co. has issued price sheets for minimum wall, seamless, carbon steel merchant boiler tubes, Edward A. Livingstone, Vice President of the Company, announced recently.

The price sheets cover cold-drawn tubes in sizes one inch and one and one-quarter inches outside diameter and hot-finished tubes in sizes one and one-half inches through six inches outside diameter, in various wall thicknesses, with cut lengths four feet to 24 feet inclusive and in all quantity brackets.

Copies of these price sheets are available upon request to the Company's sales offices at Beaver Falls, Pa.

Link-Belt Fluid Drives

Link-Belt Fluid Drives are featured in a new 28-page catalog and engineering data book No. 2385 released by Link-Belt Co. to replace previous catalogs on this subject.

This book, in effect, is a progress report on the Link-Belt Electrofluid Drive, "ED" type, which the company announced three years ago as a compact, packaged power transmission unit providing for smooth, cushioned starting of machines, smooth running under varying conditions of loading, and automatic overload protection.

The new book shows that the original "ED" type Electrofluid drive has meanwhile been applied to a large variety of applications and that it is now made in a greater number of sizes, up to 30 H.P.

The book also shows that the line has been expanded typewise. In addition to the Motorized type "ED," there is now the Gearmotor type "EG." Also included are Types "FD" and "FG" units, which are the equivalents of the "ED" and "EG" with the exception that input shafts are supplied in place of integral motors. Fluid Drive arrangements for applications as high as 200 H.P. are shown.

The contents of new book may be summarized as covering types, sizes, arrangements and dimensions of units available; features of construction; advantages to the user; selection tables; typical examples of fluid drive selections; and numerous photographs of actual installations.

Continued on Page 62

NOTHING WRONG WITH THIS BOILER'S CHART!
Charts of patients may cause concern at Children's Memorial Hospital, Chicago, but those in the boiler house are well under control. An important reason is the drive installed on the chain grate stokers: the matchless combination of Troy-Engberg Steam Engine power and Type EN Governor control.
Positive, Variable, Sensitive—Under the sensitive control of its Type EN Governor, this Troy-Engberg Steam Engine turns at 100 to 300 r.p.m. to drive a large chain grate stoker. The governor's fully enclosed, ball bearing, self lubricating construction promotes cleanliness and cuts maintenance costs.
This combination gives a stoker drive that's positive . . . flexible . . . infinitely variable. Extremely sensitive to slight changes in load, the EN Governor achieves virtually straight line speed regulation despite sudden surges of demand.
* * *
If your drive requires rugged, dependable power, the Troy-Engberg Steam Engine is indicated. If it requires accurately controlled, widely variable speed, the modern EN Governor is your answer. And if you are interested in true drive economy . . . you will want to look into the facts behind Troy-Engberg By-Product Power. No obligation, of course.
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THE RIGHT OIL BURNER OR GAS BURNER FOR YOUR JOB

TYPE "SA"
(For use where steam is available) *atomizes thoroughly* and *burns completely*, the lowest and cheapest grades of fuel oil and tar, requiring only low oil pressure and temperatures.

TYPE "S-A-L"
(Large capacity burner similar to TYPE "S-A-R") is adaptable in combination with powdered coal burners in large boilers.

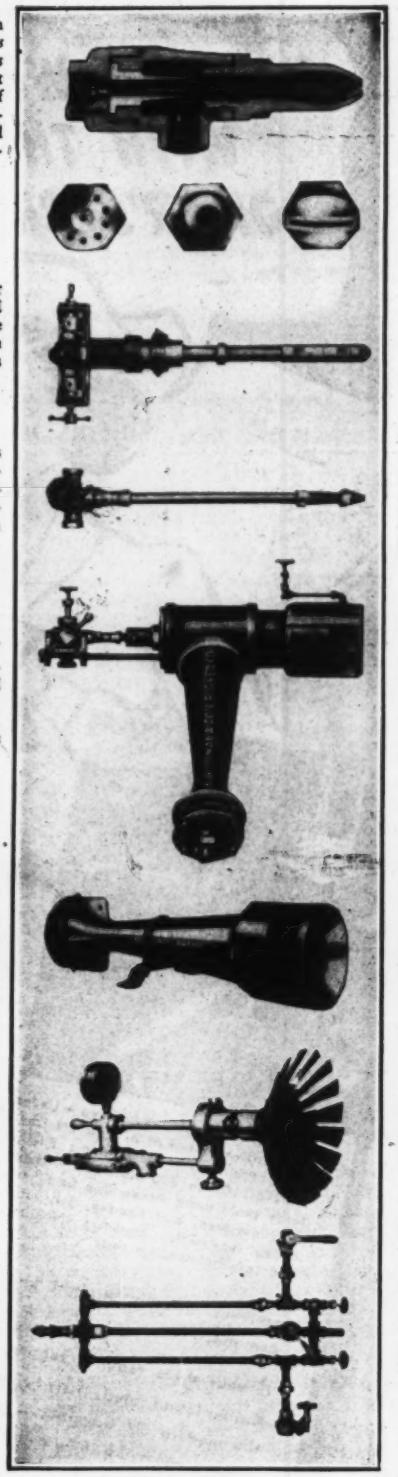
TYPE "S-A-R"
(Where steam or gas is available for atomizing) safely and efficiently burns residuums obtained from process.

COMBINATION GAS AND OIL BURNER
—the "AIROCOOL" Gas Burner in combination with a TYPE "S-A-R" Oil Burner.

"AIROCOOL" GAS BURNER
(Of venturi type) assures low turndown without burnback.

MECHANICAL-PRESSURE ATOMIZING OIL BURNERS
with multi-vane type air diffuser to give a positive swirl to entering combustion air.

TYPE "S-A-D"
(Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors, etc.



Whether you burn oil, gas or a combination of these fuels, there's a NATIONAL AIR-OIL BURNER for your job.

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OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

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Simple in principle and construction, the Electrofluid Drive permits the motor to gain speed smoothly and rapidly under low torque, thus reducing starting current and utilizing the motor's "pull-out" torque for starting.

With fluid drives, smaller motors (based on the running load rather than on the starting load) can often be used due to the no-load starting feature.

Application of the fluid drive often permits the use of lighter and more economical driven equipment with safety, since the fluid coupling limits the torque that can be imposed on driven equipment.

In addition to these desirable features, fluid drives provide automatic overload protection, eliminating troublesome mechanical shear pins.

Typical among the many applications that have been made are foundry apron conveyors, belt conveyors, cotton and wool carding machines, drag chain conveyors, tanning drums, mold conveyors, overhead cranes, punch presses, screw feeders, steel coil conveyors, ball mills, trolley conveyors, etc.

A copy of the new 28-page Link-Belt Fluid Drive Book No. 2385 will be sent to any interested reader upon request.

Bailey Combustibles Recorder

Design improvements and new applications for the Bailey Combustibles Recorder are featured in a new 16-page bulletin now being distributed by Bailey Meter Co., 1026 Ivanhoe Rd., Cleveland 10, Ohio.

Drawings and photographs explain the operation of this electronic type instrument which operates on the catalytic combustion principle. Typical applications to Boiler Furnaces, Atmosphere Producers, Rotary Kilns, Industrial Furnaces, and Chemical Processes are illustrated.

Either air or electrically-operated control of combustibles content may be had with the combustibles recorder. Both are shown and explained. Also described, is the recorder's highly accurate a-c measuring circuit

Write for Bulletin 150-A, "Bailey Combustibles Recorder."

SK Low-Level Multi-Jet Condensers

SK Low-Level Multi-Jet Condensers are pictured and described in Bulletin 5-A which has just been released.

Cut-away views and sectional drawings are used to show construction, and installation photographs and colored diagrams illustrate typical applications.

Sizes, capacities, overall dimensions and weights as well as properties of saturated steam are included in tabular form.

Copies are available by writing for Bulletin 5-A to Schutte & Koerting Co., 1166 Thompson St., Philadelphia 22, Pa.

Ball Bearings for Conveyor Systems

New Departure, Div. of General Motors Corp., Bristol, Conn., offers a new 16-page book describing and illustrating five distinct types of New Departure self-sealed and lubricated-for-life ball bearings designed for Belt and Trolley conveyors, Foundry Mold car wheels and similar applications.

It has been amply demonstrated in countless thousands of mechanisms that ball bearings when correctly applied and protected from dirt will resist all kinds of loads, and for years, without showing any material wear and without need for adjustment of any kind.

On the basis of these fundamental facts, New Departure, 23 years ago, developed the first ball bearings with built-in seals, lubricated for life, and has produced more than 147 million ball bearings of this type.

The advantages gained, particularly in miles of conveyor systems through maintenance savings, is very striking.

• Keep Informed

These bearings are developed for use with special stub shafts, round through shafts or hexagon shafts, and mountings of all types are shown.

Illustrations are line drawings with numerous photographs of installations with performance records. The book includes dimensional and load capacity data. Free on request.

Underwriters' Approved Fire Pumps

Peerless Pump Div., Food Machinery & Chemical Corp.—Bulletin B-1500 describes single and two-stage Underwriters' approved fire pumps, designated as Types AF and TUF for plant protection, utilizing water or foam. Bulletin is 24 pages, fully illustrated and with comprehensive descriptive text, plus valuable engineering data and head-capacity selection charts. Type AF capacity range: 500–2000 gpm; head range: 40 to 150 lbs. Type TUF capacity range: 500–1500 gpm; head range: 100 to 200 lbs.

G. E. Announces New Arc-Welding Accessory Catalog

A new 20-page catalog containing descriptions, specifications, and prices of more than 150 arc-welding accessories has been announced as available from the General Electric Co., Schenectady 5, N. Y.

Designated as publication GEC-253A, the new bulletin includes information on electrode holders, helmets and goggles, tungsten electrodes, all types of protective aids and clothing, electrode carriers, cable connectors, ground clamps, brushes, cleaning tools, fillet weld gage, and many other accessories for the arc-welding operator.

According to the G-E Welding Divisions, the products shown in the catalog will meet the requirements of all ordinary welding work, as well as many special applications. It does not, however, include all of the accessories that the company can furnish. Certain items, because of their newness or because of the infrequent demand for them, are not listed, it was explained.

Double Suction Single Stage Pumps

Buffalo Pumps, Inc., 495 Broadway, Buffalo, N. Y., Bulletin 955-N describes the recently redesigned line of Buffalo Single Stage Double Suction Pumps for handling certain acids and clear water. Complete rating tables are included, with dimensions, sectional views and parts lists. Also included is data on the Buffalo Class "Su" Underwriters Fire Pumps. All pumps described have the efficient Buffalo Double Suction Impeller which is always in hydraulic balance.

Optical Pyrometers

Two special lens assemblies which are being increasingly used with the standard L&N Optical Pyrometer for measuring molten steel temperatures during tapping, teeming, and spoon tests, or in the laboratory to make specialized temperature measurements, are described in a revised edition of the Leeds & Northrup Company's 16-page, illustrated catalog entitled, "Optical Pyrometer—Potentiometer Type".

This publication shows how these special lenses, which provide a larger-than-usual image, are helping operators to make easier, faster temperature readings of thin or small-area objects. In addition, the catalog shows the easy interchangeability of these special lenses with the standard one used for all usual measurements.

A typical application mentioned is the use of one of these lenses to sight at the darker, center streak of the tapping stream, and at the narrow ribbon of molten metal poured from

Continued on Page 64

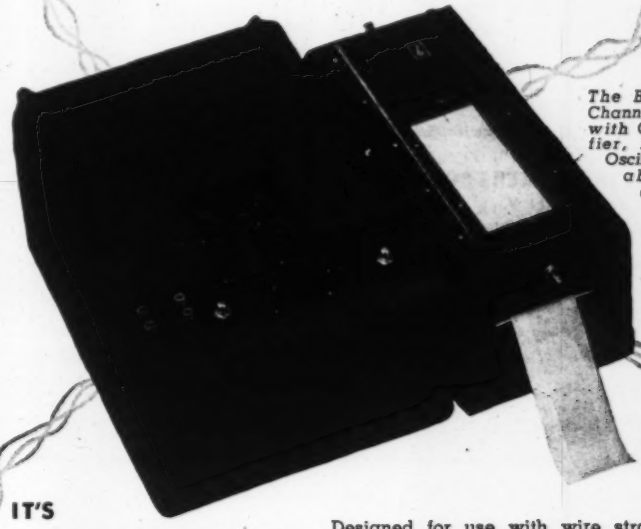
NOW... IMMEDIATE

records of strains

pressures *temperatures*

torques *vibrations or*

accelerations



The Brush Single-Channel Oscillograph with Carrier Amplifier, Model BL-310. Oscillographs available in Double and Six-Channel units also.

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"Strain Analyzer"

Designed for use with wire strain gages or other resistance sensitive elements. Two "Strain Analyzer" models are available, which, with suitable pickups, give immediate records of strains, pressures, temperatures, torques, vibrations or accelerations. Either static or dynamic phenomena up to 100 c.p.s. may be recorded.

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for Stress Determination

To the machine designer, photoelastic stress analysis is not only of value in the verification of calculations based on theoretical solutions, but also in the solution of problems where theoretical analysis is not available. Where weight and space must be conserved actual stress distribution is more important than stress indicated by theoretical analysis.

In the new model polariscope of 4¼" clear aperture, the parallel beam is collected by a rear element and condensed through a three component lens of the Cooke system. In the new larger unit (8¼" aperture) a four component lens of the Omnar system is used. *The image is sharp throughout the field, free of aberration, astigmatism and distortion.*

Literature of new model polariscope now available

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Only three moving parts. No pilot gears. No sliding vanes. No reciprocating members. Nothing to get out of order.

IMO Pumps are designed for handling oils, hydraulic control fluids and other liquids over a wide viscosity range.

Send for Catalog L-32A

I-155

IMO PUMP DIVISION of the
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

• Keep Informed

the ladle during teeming, or from the spoon during spoon tests. The catalog also tells how laboratory personnel are using the second lens to simplify temperature measurements of filaments and other hot objects 1/32 inch in diameter or less.

A copy of Catalog N-33D, "Optical Pyrometer—Potentiometer Type", will be sent upon request. Address Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

New Model "F" Highboy and Lowboy Heaters

Buffalo Forge Co., 148 Mortimer St., Buffalo, N. Y. announces Bulletin #3704 giving ratings, dimensions and all technical data on the new Model "F" Highboy and Lowboy line of heating and ventilating units. Table of air diffusion and two pages of typical arrangements are useful in selection of equipment. Information on steam systems most commonly used is also included.

New Tube Design Boosts Dust Collector Efficiency

A longer tube of relatively small diameter and having just one carefully proportioned inlet slot for flue gases, forms the basis for a new Tubular Dust Collector design, the Valmont Type S, recently introduced by Prat-Daniel Corp.

By introducing the gases in a deep, narrow ribbon, this new inlet slot materially reduces the horizontal distance a particle must travel before meeting the precipitating wall. In the time required for the gases to travel the length of the tube, it is claimed that a higher percentage of fine particles will be collected. The center outlet tube has been reduced in size to more closely approximate the center of the dust-free vortex produced by the whirling gases in the cyclone.

In this new Valmont Type S Collector the tubes are nested close together, so that gases are guided to the inlet slot by the contour of the adjoining tube. This sets up an "S" shaped path for gases, from which the model takes its name. This "S" shaped inlet path improves aerodynamic flow of the gas, resulting in greater collection efficiency and the use of fewer tubes to handle a given quantity of gas.

For full details, request Bulletin S-250-V, from Prat-Daniel Corp., East Port Chester, Conn.

Products and Engineering Literature Directory

Allis-Chalmers Mfg. Co.—Over 1600 types of products—complete lines of equipment—for farm, mine, industry and utility, together with available engineering literature pertaining to them are cataloged in this new handy directory. Location of domestic and foreign Allis-Chalmers sales offices are also listed.

Farrel-Birmingham Issues New Roll Bulletin

A new bulletin, "Farrel Rolls for Paper Mills," has been published by Farrel-Birmingham Co. The 16-page illustrated booklet tells how chilled iron rolls are made, describes the company's roll manufacturing facilities, and explains why the roll maker's experience, skill and equipment are reflected in the quality of the finished product.

Other equipment manufactured for paper mills, including machine and board calenders, roll grinders, calipers and speed reducers, are also illustrated and briefly described.

The bulletin, designated as No. 116, is offered, without obligation, to those engaged in paper manufacturing. Copies may be obtained by writing to Farrel-Birmingham Co., Ansonia, Conn.

PROFESSIONAL GUIDE for JUNIOR ENGINEERS

THIS 56-PAGE PUBLICATION, ISSUED BY THE ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT, WAS WRITTEN BY THE LATE DR. WILLIAM E. WICKENDEN, AND EDITED BY G. ROSS HENNINGER

The book seeks to give the young engineering graduate a sense of professional values in chapters on engineering origins and professional relationships. Full treatment is given to the practical side of getting an engineering job and of advancing in the profession. Also included is the Council's credo "Faith of the Engineer," a self-appraisal questionnaire, and the Canon of Ethics for Engineers.

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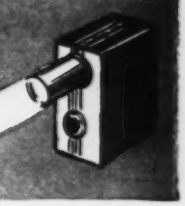

NOW AVAILABLE—General Electric photoelectric relay systems for almost every kind of a sorting, counting, limiting, or register job. There's an automatic system to meet every operating requirement—fast or slow, highly accurate, or standard. Save hours of routine, tiresome work requiring close attention. This electronic equipment is easy to install, easy to service—is the inexpensive way to solve many production, processing, and protection problems. Check the coupon for copies of descriptive bulletins. **Apparatus Dept., General Electric Company, Schenectady 5, N. Y.**

Automatic Systems

CUT-OFF REGISTER CONTROL

On paper fabricating and packaging machines results in improved product appearance, cost reduction, increased production and maximum advertising value because product is clean, neat, and has greater eye appeal.

Register is maintained automatically so accurate cut-off or any other longitudinal operation in relation to printed matter is assured. Three general types available, determined by the speed of the web and the accuracy required, as well as type of mechanical correcting mechanism used on processing machine. Bulletin GEA-4371.

Side-Register Control

To keep the lateral position of a moving web in a given relation to a processing machine this side-register control is completely automatic, and any deviation in the web is instantly detected and corrected. Results in a more uniform product, cuts waste, increases production and cuts costs. Used for slitters, rewinders, side trimmers, tenter frames, etc. Can be combined with electronic - amplidyne system, or with a rotary scanner for increased flexibility. Bulletin GEA-4410.

• • • • • • • •

GENERAL PURPOSE RELAY

For counting will operate up to 400 times a minute on pulses of 1/15 second duration with a 1/15 second time lapse between pulses. Ordinary automobile headlight bulb providing at least five foot-candles at the phototube is usually used. The relay uses a standard radio tube with an expected life of several thousand hours. Any object can cut off the light beam, and reflected light may be used to identify light and dark objects. Bulletin GEA-1755F.

HIGH SPEED HIGH SENSITIVITY RELAY

Useful in counting small articles, starting and stopping small motors, and as register control in paper and textile industries. A change of light of ½ foot-candle and signals as short as 1/1000 of a second operate the relay. Operates up to 1,000 times per minute. Bulletin GEC-279.

For Long Distance

OUTDOORS

Used for counting and limiting outdoors at distances up to 1000 feet. Provides protection against intruders in restricted areas and is used in connection with a warning device for hazardous locations. Also applicable for traffic control in parking lots and warehouses, shipping control in locks and harbors, and safety control for airplanes. Bulletin GEC-275.

Industrial Type

MEDIUM AND HIGH SENSITIVITY

Any object, no matter how delicate, will cut off the light beam—even smoke. Sensitive to a light level as low as 3 foot-candles in one form, as low as 1 foot-candle in the other. Operates up to 300 times a minute on light changes of 1/10 second or 1/20 second duration. Compact, suitable for vigorous, industrial-type service on conveyors, counters —useful for limiting, warning, protecting, and signalling. Bulletin GEA-5034.

• • •

PHOTOELECTRIC CONTROLS AND HOW THEY OPERATE

Two of 12 practical lessons in industrial electronics produced for operators of this equipment under General Electric's More Power to America program. "Electronic Relay Systems" describes the simple time-delay relay circuit and the photoelectric relay. "Photoelectric Relay Systems" describes light sources and simple optical systems. Other films cover "Fundamentals of Electricity," drives and subjects of interest to all users of electronic equipment. The sound slidefilms are one-half hour each, and illustrated review booklets, and Instructor's Guide are included. More information in Bulletin GES-3303A.

GENERAL ELECTRIC

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Schenectady, N. Y.

Please send me the coupons checked below on photoelectric relays:

- ☐ General Purpose, Bulletin GEA-1755F
- ☐ Cut-off Register Control, Bulletin GEA-4371
- ☐ Side-register Control, Bulletin GEA-4410
- ☐ Industrial Type, Bulletin GEA-5034
- ☐ Long Distance and Outdoor, Bulletin GEC-275
- ☐ High Speed, High Sensitivity, Bulletin GEC-279
- ☐ Electronics Training Course, Bulletin GES-3303A

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ASME BIOGRAPHIES

make perfect Christmas gifts

for those who enjoy good reading

Frank and Lillian Gilbreth: Partners for Life

This is the story of two people who made such a wonderful partnership of life and engineering. Frank Gilbreth is an inspiration to any professional man; for it was he who found new ways in old surroundings. His inventions of concrete mixers and adjustable scaffolds, his early appreciation of the problems of the workmen, and his keen concern for ethical relations with the public—stamp him as a man whose purpose was to put as much into life as he could, not to get out what he could. But it was the partnership which so greatly multiplied the productivities of each of the partners—which wrought the science of motion study—and which brought forth and reared the family whose hilarious story "Cheaper by the Dozen" has so skillfully been related by two of the children. It is impossible to read the story of this perfect partnership and of Mrs. Gilbreth's valiant continuation of her husband's work after his death, without realizing that both partners had inquiring, energetic, and constructive minds to an unusual degree. $5.50

Not only engineers, but all who aspire to eminence in a profession, can derive the highest inspiration from a study of the partnership of the Gilbreths . . . . . Mechanical Engineering

Scientific Blacksmith

The Autobiography of Mortimer E. Cooley, Dean of Engineering, University of Michigan. This is the story of the country boy who wanted to go down to the sea in ships, but whose long and useful life was devoted to education, to the advancement of the engineering profession, and to public service. The chapters devoted to his teaching days at the University are of peculiar interest, for Cooley lived for sixty-three years continuously at Michigan, and saw the College of Engineering grow from crude beginnings to the great institution it is today. His reflections and opinions on the engineer and the future also hold considerable interest for the engineers of today. These memoirs, written when he was past eighty, reflect a breadth of experience achieved by few engineers. $3.75

His zest for life is well reflected in the many anecdotes he tells and the salty character of his writings . . . . . Faults he had, like all of us, but, as Samuel Johnson said of Oliver Goldsmith: "Let none of his frailties be remembered; he was a very great man" . . . . . Mechanical Engineering

The Autobiography of an Engineer

This book is of fascinating human interest, giving a vivid picture of William LeRoy Emmett. While Dr. Emmett is probably best known for his invention, design, and development of the mercury vapor-power system, he was also prominently identified with three other important phases of electrical development. These include the many types of apparatus and methods of distribution used extensively in the central station electric industry, the steam turbine electric apparatus, and the electrical propulsion of ships. Dr. Emmett's adventures as a young man, his life at the Naval Academy and at sea, and the tasks which engaged his attention during his long and active career combine to make his autobiography a truly dramatic story. $3.50

ALL THREE VOLUMES ARE AVAILABLE IN THE ASME SUBSCRIPTION EDITION BINDING

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—it's easier and better the WeldELL® way—

"Taylor Forge has thought of everything!"

A construction superintendent said it, but it has been expressed in one way or another by thousands of men who have lived and worked with Taylor Forge Welding Fittings and compared them with all other makes.

From the very start, Taylor Forge did the improving: set up a rigid, seemingly unattainable set of specifications for ideal welding fittings long before they were produced on a commercial scale.

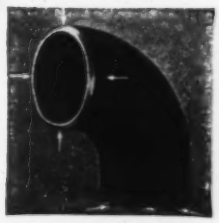
But it was easier to think of everything than to accomplish it. Only the knowledge that Taylor Forge had accumulated, only the forging skills that Taylor Forge had developed, could have produced welding fittings that please alike the men who design piping, the men who erect piping, and the men who pay the bills.

Today in the WeldELL line, you have the fittings that *ask* for comparison. Some of their plus-value features—features that are combined in no other fittings—are pointed out here. Remember that the plus-value line is also the broadest line! Coupon brings catalog.

Taylor Spiral-Weld Pipe is again promptly available in a broad range of sizes and thicknesses. Coupon brings new Spiral Pipe Bulletin 493.

1 Seamless throughout

2 Sized end-tangents



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4 Engineered for full strength

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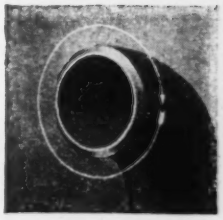
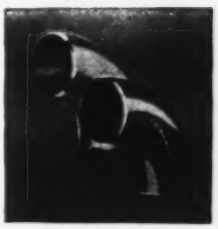


6 Machine-tool bevels and lands



7 All materials: carbon and alloy steels; corrosion resistant alloys.

8 World's widest range of sizes, types, weights.

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☐ Please send new Catalog 484 covering welding fittings and forged steel flanges.

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Each day many men in industry ask themselves this question—*Just how should I go about getting the most out of each insulation dollar?* The answer, as with any investment, depends on several factors.

First, there's the reputation of the insulation manufacturer; the type of materials he has to offer; the efficiency of those materials in saving fuel. Next, there is the kind of service the manufacturer offers for engineering and applying his insulations.

This last consideration is a mighty important one. For, assuming all other things to be equal, it is the selection of the right insulation and the correct application of it that pays off in the long run on your insulation investment.

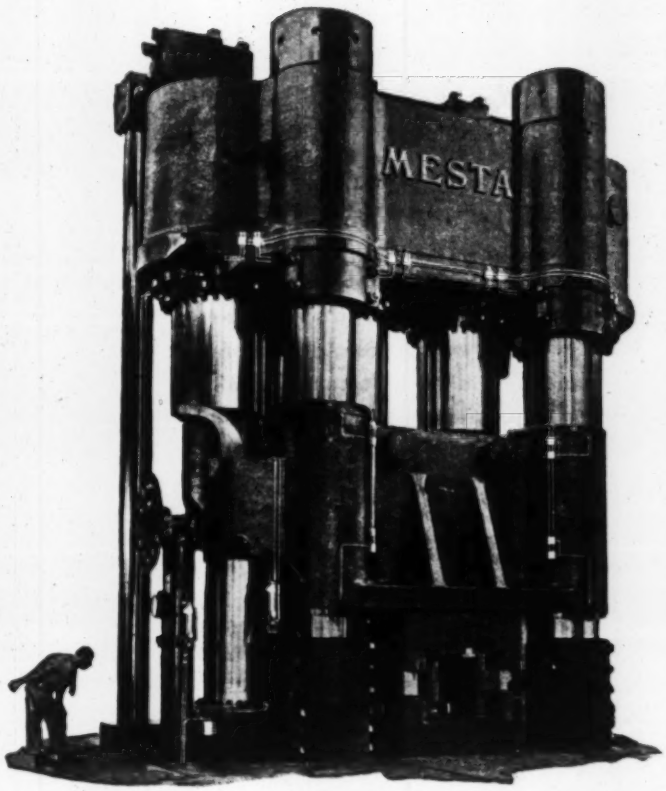
... And that's where Johns-Manville leadership in application service can be of utmost help to you. Your Johns-Manville Insulation Applicator selects the right materials for your specific job from the wide variety of J-M insulations that are available (for temperatures from minus 400F to 3000F above zero).

You will benefit by the long experience of your J-M Insulation Contract firm in all phases of insulation application . . . from engineering the job to the skill of his mechanics in applying the insulations.

If you have an insulation problem, write to the blue chip name for insulation investments—Johns-Manville, Box 290, New York 16, New York.

Johns-Manville *first in* **INSULATIONS**

World's largest forging press is lubricated with 2 Farval systems



THE builder of this 18,000-ton hydraulic die forging press made certain it would receive adequate lubrication by equipping it with two Farval systems. One serves 24 points of lubrication on the column guide bushings and plunger seat, the other serves 32 points on the gland rings of main and push back cylinders.

Hundreds of Farvalized presses are in use in forging and metal working shops. The benefits of Farval Centralized Lubrication are fourfold—oiling labor is saved, lubricant is saved, bearing expense saved and production time saved. In one plant, for example, installation of 133 Farval systems to serve 3100 bearings on metal-forming presses saved the labor of 11 oilers per day.

In another plant, Farval solved the problem of delivering oil regularly and adequately to the Pitman bearings of a large forging press, thereby ending frequent shutdowns for overhauls costing $3500 to $5000 each in parts and labor alone. In a third plant, five Farval-equipped dieing machines ran continuously for 10,000 hours, while alongside, 12 similar machines without Farval had to be shut down every four hours for hand oiling. Thus production was increased 14% on the Farval-equipped machines and maintenance was only ¼ as great.

Farval has proven itself in over 20 years of service. It is the original Dualine system of centralized lubrication that others imitate. The Farval valve has only 2 moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its wide valve ports and full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned. For a full description, write for Bulletin No. 25.

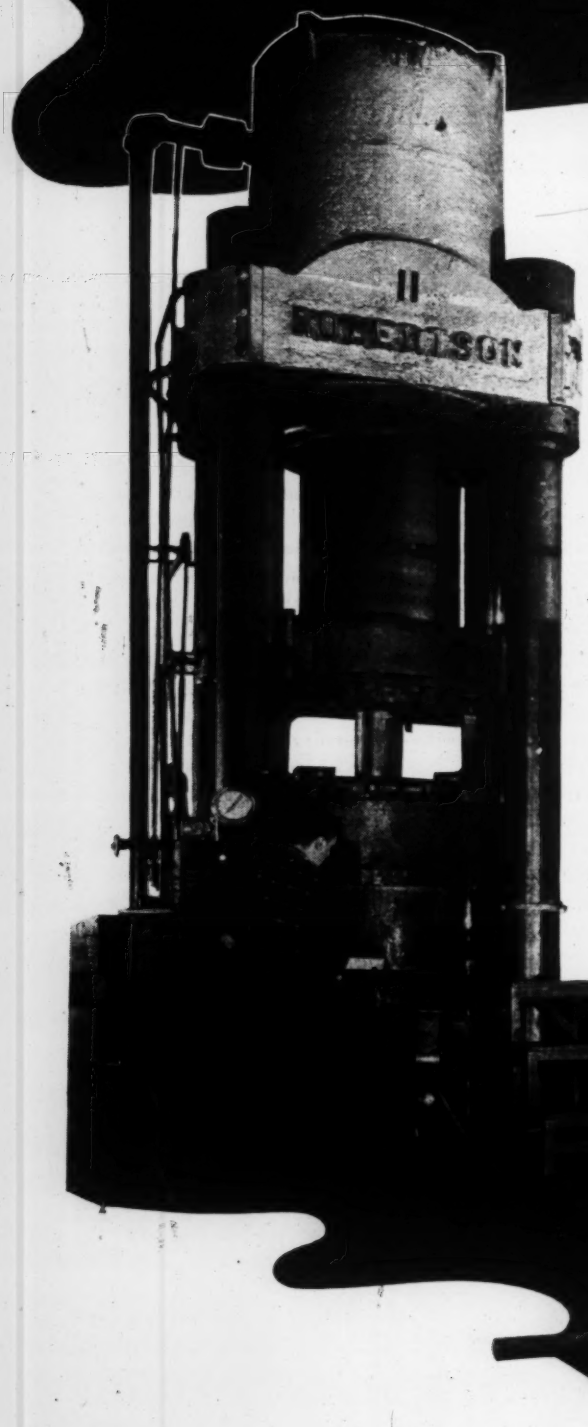
The Farval Corporation, 3264 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

FARVAL—*Studies in Centralized Lubrication*
No. 107

Consistent, low-cost production

...WITH ROBERTSON CABLE LEAD ENCASING PRESSES



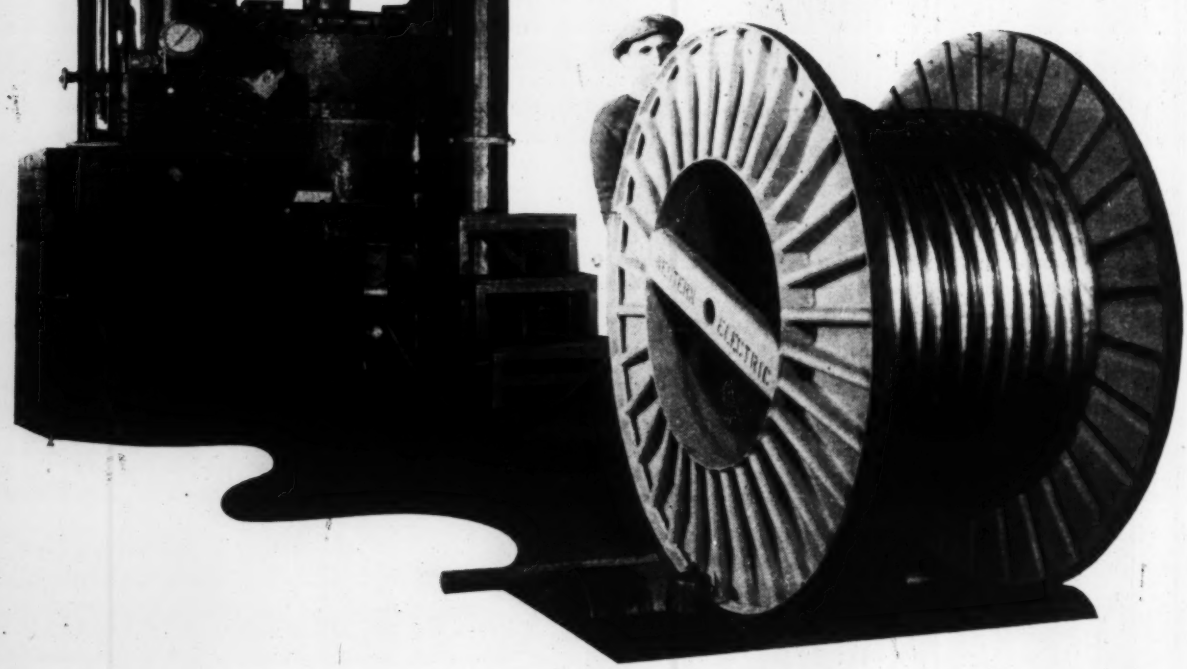
To help produce vital power and communication lines throughout the world, leading manufacturers of wire and cable employ Robertson High Pressure Hydraulic Presses. They know that, year in and year out, Robertson Equipment stands up under the most severe production schedules—assuring lower operating and maintenance costs, and consistently producing a uniform product that invites customer satisfaction . . . If you have a lead encasing problem, we will be glad to help you in any way possible. Consult our experienced engineers without obligation.

JOHN **Robertson**

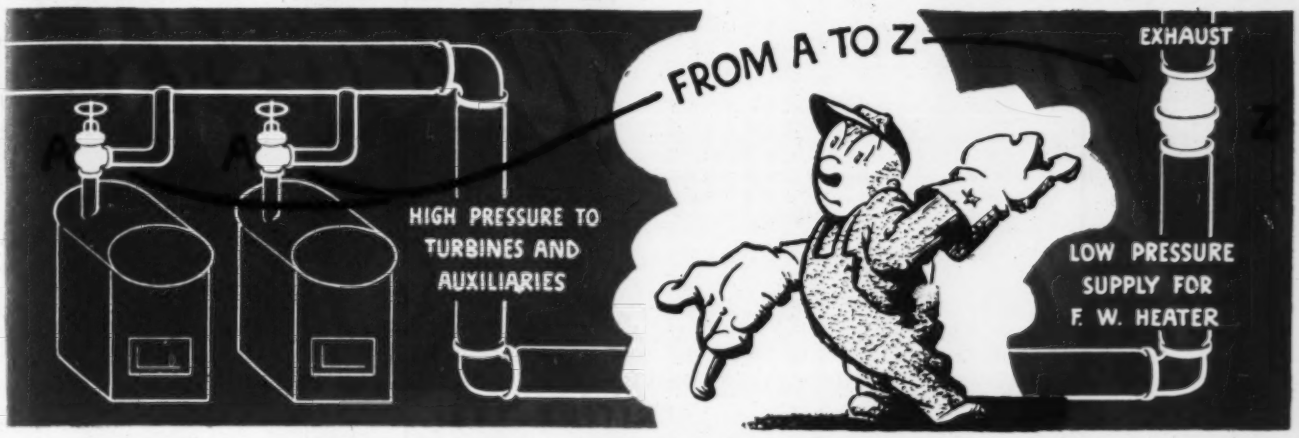
121-131 WATER STREET, BROOKLYN 1, NEW YORK

Designers and Builders of all Types of Lead Encasing Machinery

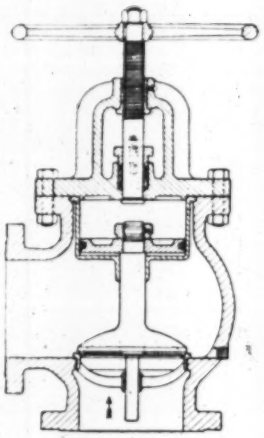
Since 1858



SAVE MONEY IN YOUR PLANT



—with FOSTER AUTOMATIC VALVES



FOSTER AUTOMATIC NON-RETURN Stop and Check Valve, Type 2

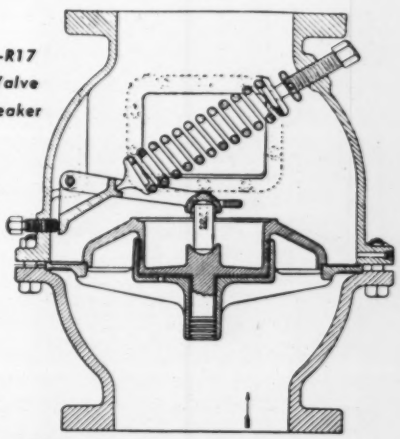
A . . . On your boiler drums, Foster Automatic Non-Return, Stop and Check Valves save money by doing their job perfectly—with the absolute minimum of attention—for years. It is not unusual to find these valves still giving good service after 25 or 30 years and more. Today's valves are even better.

There's nothing skimpy about a Foster Type 2. Full pipe area means negligible pressure drop across the valve. Heavy duty, through bolted construction makes it safe to work under when the boiler is down. Low pressure types to 250 lbs. (stocked) have semi-steel bodies, bronze trimmed, with stainless steel seat rings; high pressure types to 1,500 lbs. have cast steel bodies, trimmed with special heat resisting, corrosion resisting alloys. Piston chambers are renewable. They're built for lifetime service. Globe, angle, or elbow, from 2½" to 12".

Z . . . The R-17 Back Pressure Valve saves money by keeping the pressure where you want it on the exhaust side—for your feed water heater or other low pressure equipment—with a minimum of maintenance. Large pipe area, and large valve area mean low pressure drop across the valve, and sensitive action at low pressures. Saves make-up steam. Adjustable in ounces.

The R-17 has no outside stuffing boxes or external weights. Loading spring is on the atmosphere side of the valve and is accessible for inspection through a large handhole. Renewable seat ring and dash pot. 2½" to 20", (with sizes from 4" to 12" stocked).

Foster Type 34-R17 Back Pressure Valve and Vacuum Breaker



• • • All along the line—Foster Pressure Regulators, Temperature Regulators, Pump Governors, Float Valves, Safety Valves, Check Valves, Relief Valves and Safety Valves are designed and built to save money, by giving reliable, trouble free regulation with a minimum of maintenance. When you select the proper Foster Valve and install it correctly, you are making a sound investment, backed by more than 70 years of practical experience in building good valves, and our reputation for service.

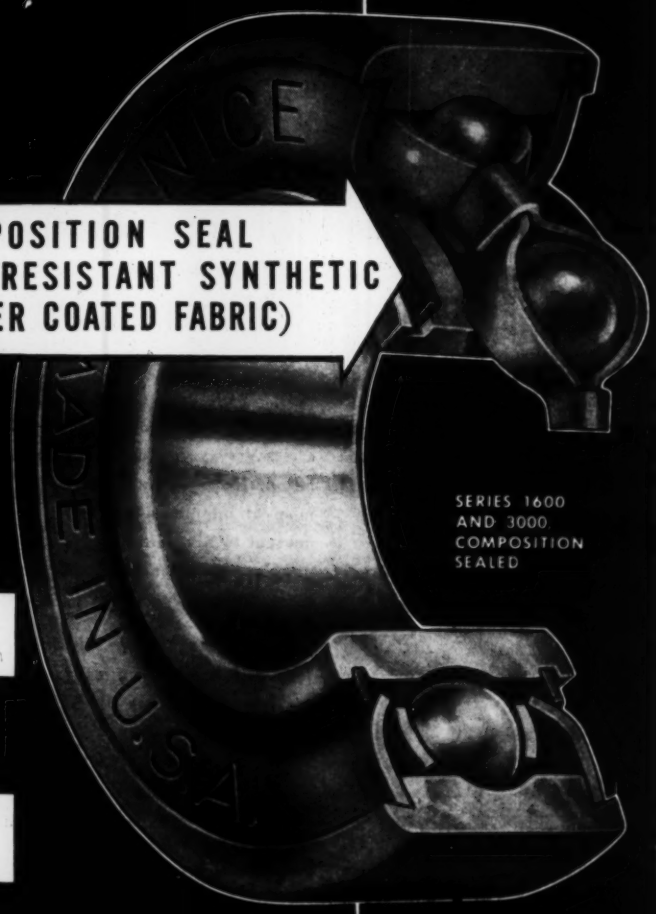
FOSTER ENGINEERING Company

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . AUTOMATIC STOP AND CHECK VALVES . . . ALTITUDE VALVES . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN VALVES . . . VACUUM REGULATORS OR BREAKERS . . . STRAINERS . . . SAFETY VALVES . . . SIRENS

835 LEHIGH AVENUE • UNION, N. J.

Announcing!

Composition Sealed Bearings by NICE



Exhaustively field tested and proven highly successful, the NICE composition seal design effectively retains lubricant and excludes foreign material. Thus, NICE has added the performance advantage of an efficient seal to the already basic advantage of a quality bearing at comparative low cost.

Write for New Catalog No. 140

NICE

NICE BALL BEARING COMPANY
NICETOWN · PHILADELPHIA · PENNSYLVANIA

Bundyweld*... keyed to your tubular needs

Want an open door to faster production, lower costs, higher quality, or better design in your tubular applications?

Latch on to Bundyweld Tubing!*

Bundyweld, made of steel, Monel, or nickel, is double-walled from a single strip, and copper-bonded throughout . . . for extra-strong tubing that's lightweight, ductile and leakproof, too. It can be bent without fear of its weakening or collapsing structurally, and is easily fabricated.

Manufacturers in such diverse fields as television, radiant heating, refrigeration, ranges, tubular toys and automobiles—to mention only a few—have found Bundyweld to be the answer to their tubular needs.

Chances are that this miracle tubing of industry can help solve your manufacturing problem . . . whether design, structural, or functional . . . even though you may not seem to need a tubing at all. Why not give it a try? Contact your near-by Bundy representative among those listed below, or write direct to: *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

ENGINEERED TO ® YOUR EXPECTATIONS

*REG. U. S. PAT. OFF.

WHY BUNDYWELD IS BETTER TUBING

1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.

2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.

3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.

4 Bundyweld comes in standard sizes, up to ⅝" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES

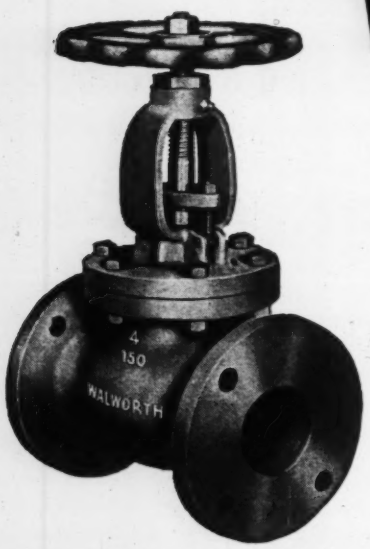
Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • *Chattanooga 2, Tenn.:* Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. *Chicago 32, Ill.:* Lapham-Hickey Co., 3333 W. 47th Place • *Elizabeth, New Jersey:* A. B. Murray Co., Inc., Post Office Box 476 • *Philadelphia 3, Penn.:* Rutan & Co., 404 Architects Bldg. • *San Francisco 10, Calif.:* Pacific Metals Co., Ltd., 3100 19th St. • *Seattle 4, Wash.:* Eagle Metals Co., 3628 E. Marginal Way • *Toronto 5, Ontario, Canada:* Alloy Metal Sales, Ltd., 881 Bay St.

BUNDYWELD NICKEL AND MONEL TUBING IS SOLD BY DISTRIBUTORS OF NICKEL AND NICKEL ALLOYS IN PRINCIPAL CITIES.

Newly Designed Walworth Valves to combat corrosion

Walworth 150-pound Stainless Steel Gate Valve . . . available in sizes ½ to 3-inch, screwed; ½ to 12-inch, flanged.

Made of Stainless Steel
Monel · Nickel
Acid-resisting Bronze
Ni-resist



Walworth 150-pound Stainless Steel Globe Valve . . . available in sizes ½ to 3-inch, screwed; ½ to 6-inch, flanged.

Sectional view of Walworth 300-pound Stainless Steel Gate Valve . . . available in sizes 2 to 6-inch, flanged.

— ENGINEERED AND TESTED FOR TOUGH . . . HARD SERVICE

Walworth offers a comprehensive line of valves made of several cast stainless steels and special alloys for piping services where corrosion is a factor. These valves are available in Gate, Globe, Angle, Check, and Lubricated Plug types.

Gate, Globe and Angle Valves have outside screw and yoke construction, thus keeping the stem threads out of contact with the corrosive material in the line. They also have a two-piece bolted gland with ball-type gland follower to prevent binding the stem when packing bolts are tightened. Gland eye-bolts can be conveniently swung out of the way without danger of loss when the gland is lifted for repacking.

Gate Valves have taper seats with a unit consisting of two flat faced discs supported by a carrier on the end of the stem. The discs are of a proven ball-and-socket type. They are free to rotate and adjust themselves to the body seat angles, assuring tight seating with no possibility of sticking in any position.

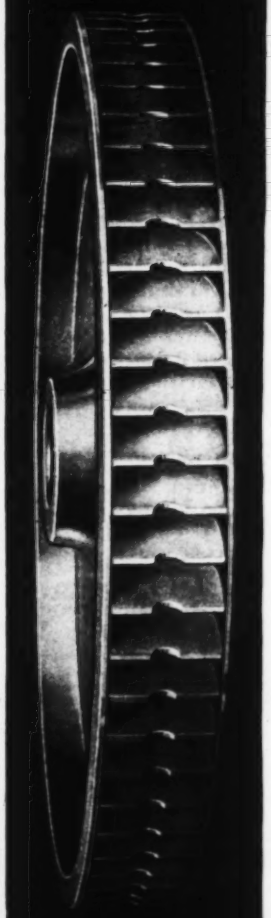
For further information about Walworth's full line of corrosion-resistant valves, see your Walworth distributor.

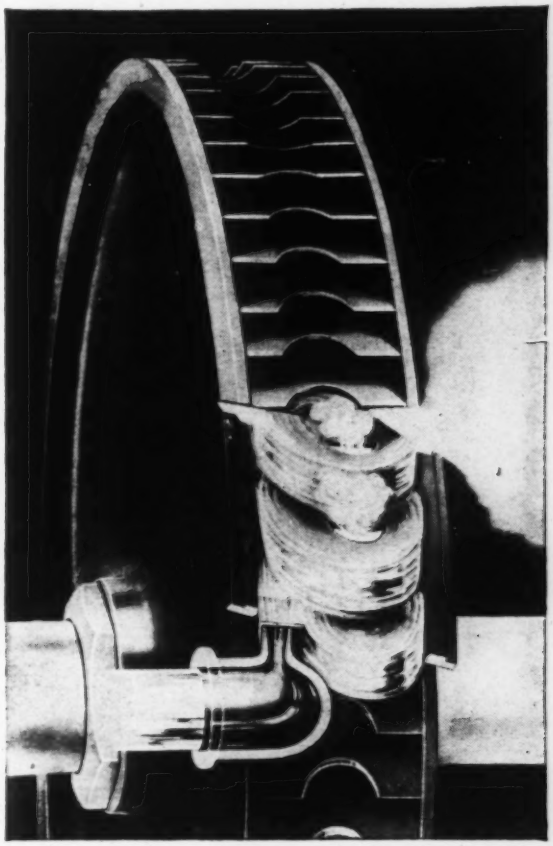
WALWORTH
valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

TERRY





Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

NO PARTS TO LOOSEN OR WORK OUT

The rotor of the Terry Wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the solid curved backs of these buckets or pockets. Therefore close clearance is unnecessary and wear on the blades forming the pockets is of little consequence, as it does not materially affect horsepower or efficiency.

For detailed information about this effective construction and its advantages, write us on your business letterhead for a copy of Terry Turbine Bulletin S-116.

T-1172

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

M=PT ... BASIC FORMULA FOR DESIGN ENGINEERS

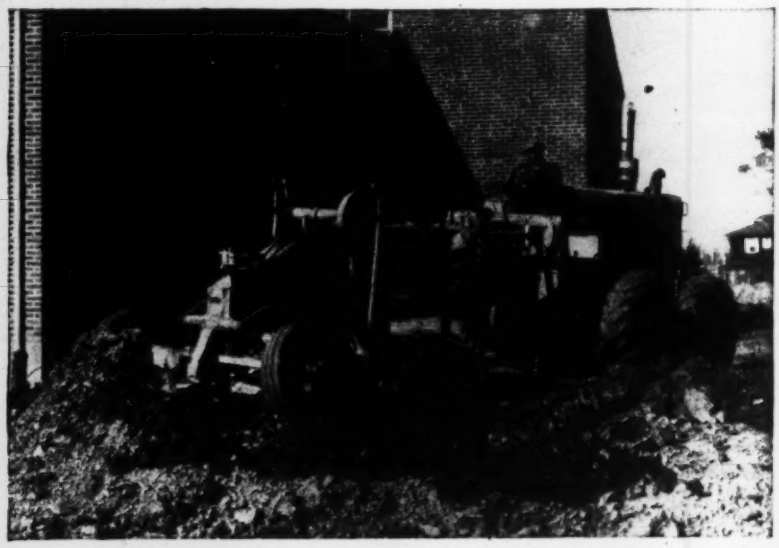
To solve a problem concerning power transmission, apply the formula M = PT (Morse means Power Transmission) and you'll find . . .

1. That Morse Roller Chains and Sprockets are most *easily adaptable* to your specific design needs.

2. That Morse Roller Chain Drives have *extra-long service life* because every phase of their manufacture and assembly is under rigid quality control and precision engineering supervision.

3. That Morse Roller Chain maintenance is *extremely low* due to the use of the finest quality materials in their manufacture.

4. That Morse Roller Chain Drives are *quickly obtainable* from shelf stock. *Ask the Morse Man* from any of the hundred Morse Branch Offices and Distributors. Each is staffed with engineers experienced in every mechanical power-transmission application.

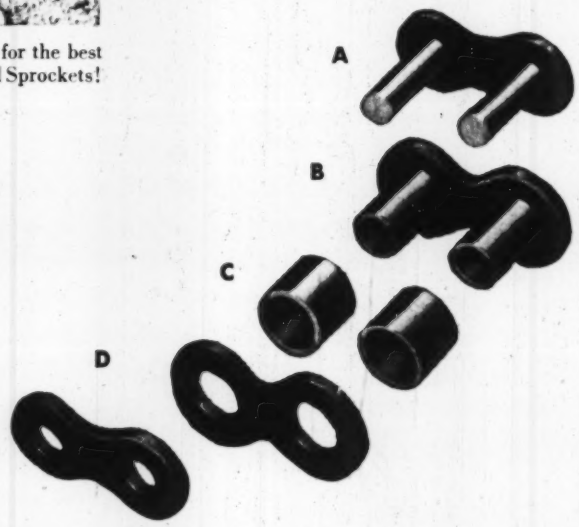


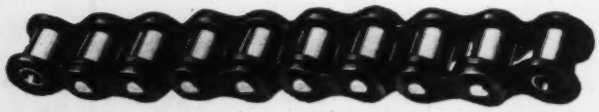
Shaving the face of the earth with a Gargantuan blade is a job that calls for the best and most rugged in power transmission equipment—Morse Roller Chains and Sprockets!

Why Morse Roller Chain Drives Are Specified For The World's Toughest Jobs

For the world's biggest and toughest earth-moving jobs, many road graders and 'dozers now use Morse Roller Chains to transmit power to forward and rear drive wheels. Precision-made, positive-acting Morse Roller Chain Drives are the design engineer's favorite method of transmitting power where *dependability* and long, rugged *service life* come first! When your design calls for roller chain . . . call the nearest Morse Man!

Exploded View of Morse Roller Chain Shows Why It's Specified By Design Engineers





Morse Roller Chains are made in all standard pitches and widths in accordance with specifications approved by the American Standards Association to assure complete interchangeability with all other standard roller chains and sprockets.

ASK the Morse Man nearest you . . . today!

From coast to coast there are more than 100 offices, representatives and distributors of Morse Power Transmission products to give you quick information and service when you want it—where you want it. *Ask the Morse Man first in any case!* Check your classified phone directory under "Power Transmission" or "Chains."

A Morse Roller Chain pins are made from special, high-nickel, fine-grain alloy steel. They are heat-treated and finished for extra strength and extreme resistance to wear.

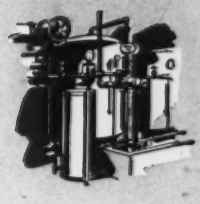
B Bushings are curled from high-quality alloy steel to give the smoothest possible O.D. and I.D. Smooth inner surface and true roundness eliminates scoring of pins and results in longer life. Bushings are case-hardened.

C Rollers are heat-treated for toughness to provide maximum strength and the greatest possible resilience to shock.

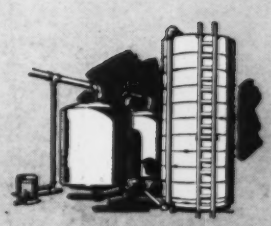
D Plates are heat-treated for structural strength and endurance. Apertures are accurately pierced and sized to provide rigid retention of pins and bushings through proper press fits.

five basic power plant processes...

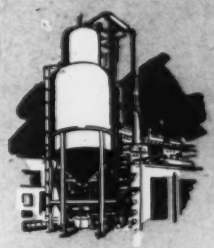
ZEO-KARB SOFTENER The Permutit Zeo-Karb® Softener removes both hardness and bicarbonates from raw water. The effluent is soft and reduced in total solids and alkalinity. The sulphate-carbonate ratio may be adjusted as desired by a system of mixed effluents.



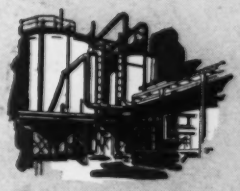
SILICA REMOVAL PLUS DEMINERALIZATION Demineralization by cold ion exchange processes produces water of comparable quality to distilled water at a small fraction of the cost of distillation. Treatment by an anion exchange resin, Permutit S,® reduces silica to less than 0.5 ppm.



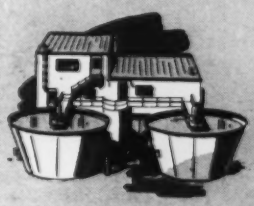
DEAERATING HEATER The Permutit Deaerating Heater, utilizing exhaust or bled steam, prevents corrosion of feed lines, stage heaters, economizers, and boilers by removing *all* oxygen and free CO_2. Capacities from 12,500 to 1,400,000 pounds per hour are in service.



SLUDGE BLANKET HOT LIME SODA The application of the sludge blanket design to hot lime soda treatment gives you soft water of a low silica content. Lower turbidity eases the load on the filters... savings in operating costs are substantial.



PRECIPITATOR The Permutit Precipitator is used to lower alkalinity, reduce hardness, and help to remove turbidity. It can also be used to reduce silica.



Consult Permutit without obligation on any of these processes. Our know-how in water conditioning, backed by 35 years experience, can provide the answer to any water treatment problem. Write to The Permutit Company, Dept. ME-12, 330 West 42nd Street, New York 18, N. Y., or to the Permutit Company of Canada, Ltd., Montreal.

Permutit

Water Conditioning Headquarters For Over 35 Years

How TIMKEN® bearings transmit 16 speeds smoothly

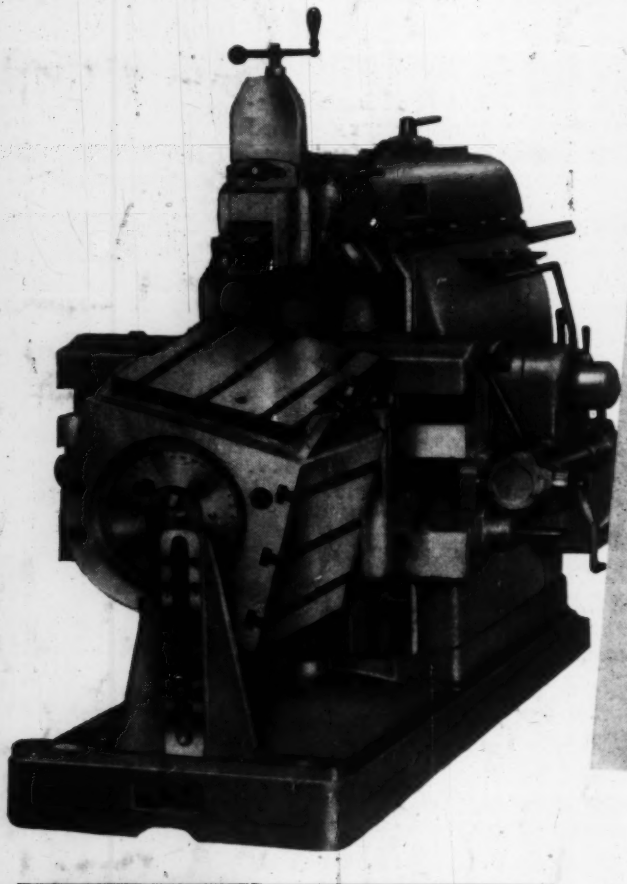
SIXTEEN speeds, all-helical gear drive, feature the new line of Gould & Eberhardt Shapers. Selective transmission gears are all mounted on Timken® tapered roller bearings. Timken bearings are also used for the rapid traverse drive, pump drive, and the cross-feed screw.

The line contact and tapered design of Timken bearings add up to extra load-carrying capacity for any combination of radial and thrust loads. And true rolling motion and precision surface finish combine to cut friction to a minimum. It all results in smoother gear mesh, less wear, and a more efficient transmission of power.

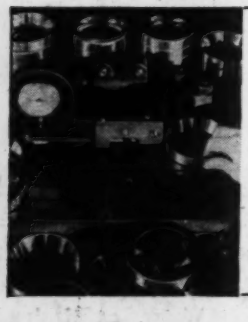
Timken bearings are made of the best alloy steel ever developed for tapered roller bearings — Timken fine alloy steel. Case hardening gives them wear-resistant surfaces and a tough inner core to withstand heavy shock loads. They're engineered to last as long as the machine.

Give the products you make an added sales feature by equipping them with Timken tapered roller bearings. And when buying new equipment always look for the trade-mark "Timken" on the bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Phantom view of G & E 16-speed shaper transmission, showing pulley shaft and transmission gear shafts mounted on Timken bearings.



WITHIN ONE HALF A THOUSANDTH OF AN INCH!

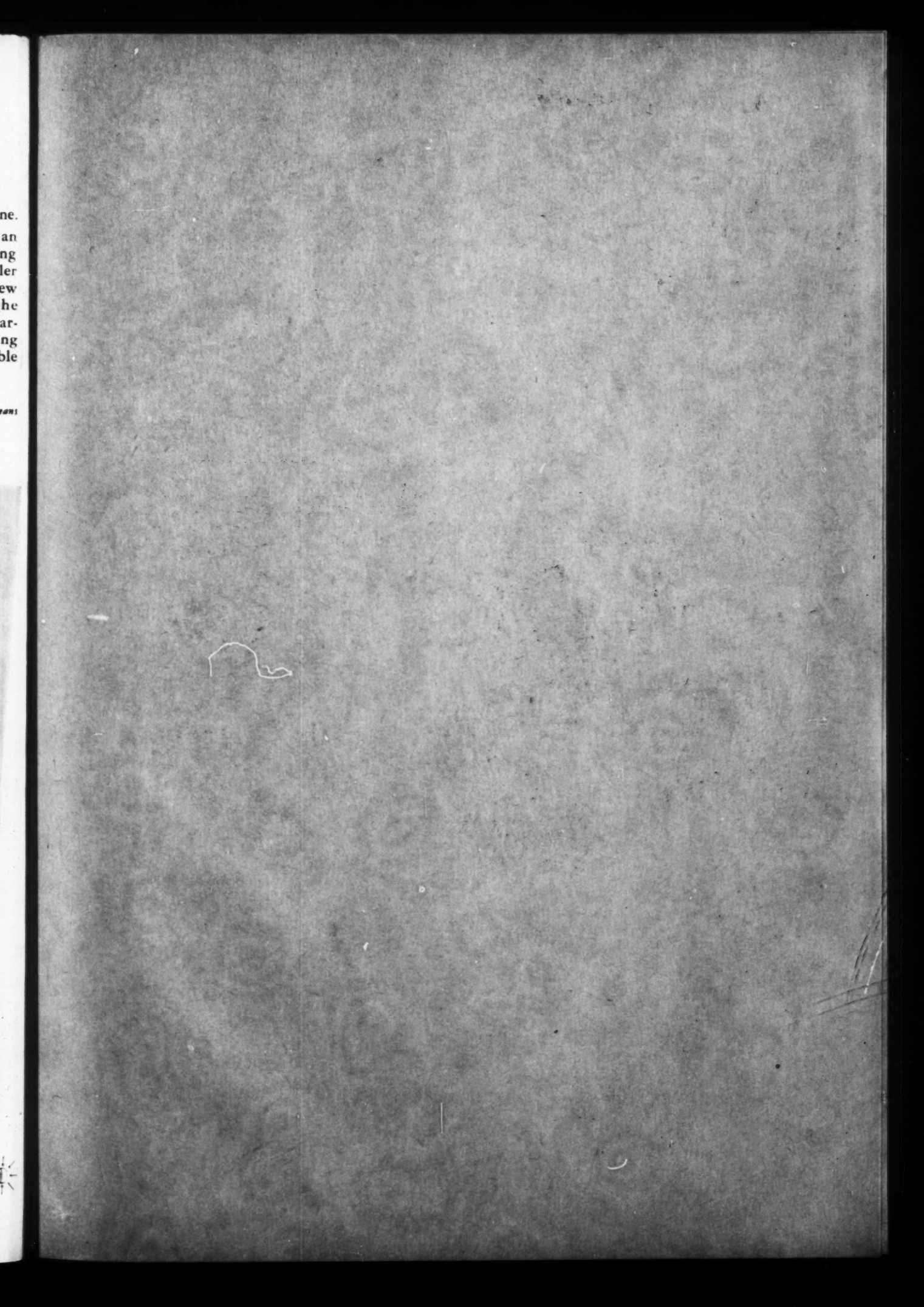
. . . that's an example of the accuracy demanded in the outside diameter of Timken bearing cups in order to pass inspection.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

TIMKEN 1899 50 1949 YEARS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ↕ AND THRUST →○← LOADS OR ANY COMBINATION